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DAILY EDITION

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It is due to our readers, and especially to the members of the American Railway Engineering Association, that explanation should be made of our action in copyrighting the contents of The Daily. It is well known that we have from year to year incurred much expense for the purpose of furnishing our readers with early, complete and properly edited stenographic reports of the proceedings of the conventions of these associations. It has likewise been the custom of other publications boldly to appropriate column after column of these edited reports of the proceedings and republish them. They have not said "by your leave;" they have given no credit whatever to the Railway Age Gazette. This habitual pirating of the fruits of our labors and expenditures has become intolerable; and we have copyrighted all of the reading pages of The Daily for the purpose of stopping it.

We desire in this connection expressly to disavow any desire or purpose to interfere with the publication or use by the association or its members of either its own reports of the proceedings, or of the reports made by the Daily Railway Age Gazette. So far as the proceedings of the convention are concerned, our copyright covers them only as they are reported by the Daily Railway Age Gazette. And the association and its members individually are hereby authorized to make any use they desire of our reports, except that they must not be republished without the express permission of the Simmons-Boardman Publishing Company, in any publication or periodical except those issued by the American Railway Engineering Association.

It is probable that the decision of Committee No. X, on Signals and Interlocking, to present its report on subject No. 1 of those assigned to it was reached only recently, and that the committee was influenced by the action of the Signal Association in rejecting the report of its own committee on Signaling Practice, the membership of which is practically identical with that of Committee No. X. The decision, however, was undoubtedly the proper one. The favorable vote of the Signal Association, while it failed to reach the two-thirds required, nevertheless was sufficiently large to indicate a more thorough understanding and appreciation of the report than has existed in previous years. The difference between the majority and the minority sentiment in both committees appears to be more than ever a difference merely in point of view, and not an inherent incompatibility of view. The present report, based on the rejected report of the Signal Association, is the result of several years' hard work, during which the various propositions offered by both sides have been argued to the point where further argument can do little good. In fact, to reopen some of the old discussions would undoubtedly put the whole subject back where it was several years ago, without helping to settle the matter. It is better to "let well enough alone," as the committee has done. A unanimous report, which will receive the indorsement of a two-thirds vote next year, is much more likely to result than if another course were taken.

One of the most important duties of the American Railway Engineering Association, and one to the performance of which a large part of the time of the various committees is now being devoted, is the preparation of specifications governing the design, manufacture and use of different materials. With the large representative membership which this association has, a specification prepared as a result of careful committee study, and then discussed before the entire convention, should represent the best recommended practice of the most of the roads of the country. Among the committees presenting specifications this year are those on Track, Iron and Steel Structures, Rail, Water Service, etc. The use of these specifications just as they stand will very probably not be found practicable by any one road, for the specifications prepared by an association of this kind should be sufficiently general to cover all conditions, and should be modifiable to meet local conditions. But as the chairman of the committee on Iron and Steel

Structures emphasized Tuesday morning, any clause which cannot be applied to one road can be eliminated by a stroke of the pen; and, therefore, a standard set of specifications may be used to advantage as the basis on which specifications applicable to local conditions on any road can be readily drawn. Without such a guide the preparation of specifications is a difficult problem, and at best numerous contingencies will very probably be unforseen. One of the most valuable results of the association's work is this preparation of specifications to cover the common problems, and it should continue until the field is well covered.

The American Railway Engineering Association is a great technical organization. It is doing as important work to promote the development of economy and efficiency in transportation as any other organization in the world. It ought, therefore, to be given not only the moral but the generous financial support of the railways that are benefited by its labors. President Cushing's address yesterday morning shows that this is not the case. The association's expenses have within recent years been increasing faster in proportion than its receipts. The increase in its expenditures has been due chiefly to an increase in the amount of printed matter issued. For the purpose of reducing its expenses, the association has adopted various means, which were set forth by Mr. Cushing. To add to its receipts it has adopted the plan of employing an advertising agent to secure advertisements for its bulletins and program. The report of the committee on Publications indicates that this plan promises to be less successful than was anticipated. President Cushing clearly indicated that, as a matter of principle, the membership of the board of direction is opposed to the solicitation of advertising for the bulletins and reports, and that it hopes to abolish it at a future date. The scheme is objectionable because, in the first place, a great railway organization such as the Engineering Association, cannot, without a sacrifice of dignity —and, as Mr. Cushing recognizes, of principle also—ask the supply concerns to help pay its expenses, either through advertising or in any other way. Furthermore, the experience of some other organizations that have had advertising agents solicit for their publications has shown that the agents, in order to get business, are apt to make promises which the association cannot properly keep, and thus to involve it in embarrassments. If, as is only fair to assume, all the expenses the Association has incurred have been necessary to carry out its high and important purposes, it is the duty of the railway companies to supply sufficient funds to enable it to meet all of its reasonable and necessary expenses. It would seem, therefore, that to meet the conditions which Mr. Cushing described the American Railway Engineering Association should turn, not to the supply concerns, but to the American Railway Association. Probably there is no good reason why the railways should not bear all of the expenses involved in the work of the Engineering Association; and there is clearly no reason why they should not supply whatever funds are needed in addition to those that the Engineering Association can obtain through the channels that have been used in the past.

PROPER SIZE OF TIES.

The size and length of ties necessary to withstand the loads imposed upon them by the motive power and equipment in use now is a subject of much interest, on which widely varying views are expressed by men who have closely studied it. As the weight of equipment, the speed of trains and the density of traffic have increased, it has been necessary to increase the strength of the entire track structure. Embankments have been widened, heavier rail laid and more ballast used. The number of ties has likewise increased from 16 to 20 for a 33-ft. rail. While probably it would be theoretically advisable to use even more ties, it is not practically possible because of the difficulty of tamping them. This difficulty makes it impracticable to decrease the distance between ties to much below 12 in.

As it is not possible to use more ties, the problem is to increase the bearing area by increasing their size. This may be done by adopting either longer ties or wider ties. Very little has been done in either direction, but of the two, the use of longer ties would probably be regarded with more favor. Here, again, there are practical objections. Longer ties are in more danger of breaking if unevenly tamped. Furthermore, some men question whether any additional length of tie over 8 ft. carries its proportion of the load. The use of longer ties retards drainage in some cases, owing to the use of more ballast for properly surfacing. However, upon a well-ballasted road this objection will not apply.

A larger tie requires more timber, and in some parts of the country this might be a serious objection because of insufficient timber at present. The increased cost, however, is the principal objection. Many engineers refrain from recommending the use of longer ties for this reason, and this, possibly, is the explanation of the apparent discrepancy in the table presented in the report of the committee on ties, in which, although 59 per cent. of the mileage voting believed a 6 x 8 x 8 ft. tie too small, only 4 per cent. thought a larger tie desirable. However, it would be equally logical for an engineer to advocate, on the ground of expense, the use of a 66 or 75 lb. rail in a heavy line. Ties 9 ft. long have been used in a few locations, and good results have been reported in most cases. It is said that the Louisville & Nashville uses 10-ft. ties with sand ballast and has no difficulty with drainage or with ties breaking under the rail. This road now uses blast-furnace slag for ballast, and a 9-ft. tie is standard. In a report presented to the Canadian Society of Civil Engineers in January, D. MacPherson, assistant chief engineer of the National Transcontinental Railway, reported an instance in his personal experience about ten years ago, where a great deal of trouble was met in maintaining to line and surface on 8-ft. ties a piece of track about one-half mile long, extending over a muskeg on the Canadian Pacific. As an experiment, ties 12 ft. long were tried, and ties of that length have remained in use at this point ever since with entirely satisfactory results. The roadmaster recently advised that he had had no trouble with the long ties breaking and that during the past summer he had treated another muskeg the same way with the result that a half mile of the 7-mile section, which, with 8-ft. ties had taken 50 per cent. of the section gang to keep in order, had since scarcely needed any attention and had remained in good line and surface.

A number of roads have experimented with 9-ft. ties recently, and are obtaining good results. The Burlington is making such an experiment a short distance west of Chicago and the results so far are strongly in favor of the longer tie.

A theoretical solution of this problem is not practical because of the inter-relation existing between the rail, the tie, the ballast and the roadbed. The weakness of any one of these component parts places an additional strain upon the others, while the reverse is also true. The use of a heavier rail decreases the load upon the individual tie by distributing it over more ties. A good depth of ballast receives the load from the tie evenly and distributes it to the roadbed. The increased use of tieplates in recent years has done much to protect the tie from mechanical wear by distributing the load on the rail over a larger area. Because of this close relation it is not yet possible to consider the tie problem separately, but it must be considered in connection with the track structure as a whole. The entire

problem is essentially an economic one, and it must be decided whether it is cheaper to adopt a heavier rail section, use a larger tie, or use more ballast. There is room for improvement in all of these features, and each will probably be improved from time to time until the practical limit is reached in each case. If, after these developments, loads continue to increase beyond what the track can bear, it will become necessary to consider some other type of track construction.

SHOULD RAILWAYS DICTATE RAIL MAKING METHODS?

Doubtless most of the members of the American Railway Engineering Association have read the able paper on the rail situation that was read by President W. C. Cushing at the hearing on the rail question before the Indiana railway commission on February 20. In that address, which was published in the Railway Age Gazette of March 1, Mr. Cushing raised one point the importance of which promises to loom constantly larger the more the rail problem is considered. This relates to the extent to which the railways should seek to control, or even influence, the specification or the methods of manufacture to be used in the making of rails.

Mr. Cushing recalled that for some time the railway engineers believed that it was best for the roads to specify a definite amount of discard, while rail makers took the opposite view. He quoted the engineer of one of the steel companies as saying some years ago that no association should state definitely how much should be sheared from the bloom. "The matter is entirely one-sided." Mr. Cushing quoted, this engineer as saying, "If we agree here that 25 per cent shall be sheared from the bloom, we might assume that would settle it, but it would not. If the manufacturers can remove the piping by shearing 15 per cent they will not agree to shear 25 per cent. The object in shearing is to get rid of the piping, and the only matter of agreement will be to reach the point where sufficient shearing is done to remove the piping." The railway engineers who then opposed this view now accept it, because, as Mr. Cushing said, "the records of rail failures which have been kept for a number of years disclose the incontrovertible fact that where a 15 per cent discard might do for one ingot 50 per cent would not be adequate for another."

Does not the reversal of the attitudes of the rail makers and railway engineers on this point and the causes of it have a significant bearing on the entire rail problem? Ought the railway engineers to try to specify to the rail makers either the chemical composition or processes of manufacture that must be used? Ought they not rather simply to tell the rail makers that they do not care how they make rails, just so they make good ones, and that the main things that the railways want are tests of the finished product to determine if it is good and a guarantee of the service that the rails will give? It is unusual in commercial affairs for the buyer to try to tell the seller how to make the commodity that the buyer wants. Ordinarily, the buyer simply insists that he shall be given value received for his money. He does not ordinarily know or care how the article he is buying is produced.

When the buyer does tell the seller how the commodities he buys shall be made he necessarily thereby assumes responsibility for the results of the adoption of the method of production which he dictates. Now, the buyer of an article is less apt to know how it can best be made than the manufacturer with his long experience in, and intimate knowledge of the making of it. This point is illustrated by the modest amount of success that the railways have thus far had in their attempts to tell the steel makers how they should make rails. The rails have not been improved as much as conditions demand. When the reasons for this have been inquired into the rail makers have put the blame on the specifications drawn up by the railways, in spite of the fact that they have refused to accept certain of these specifications; and in the circumstances it has not been practicable for the roads effectively to disavow a considerable share of the responsibility.

The fact that the quality of the rails turned out by different mills while using the same specifications varies widely demonstrates that the process of manufacture is as important, and probably more so, than the chemical composition; and while the railways can control the matter of chemical composition it is very doubtful if they can control, or to any very considerable extent influence, the methods of manufacture, except by insisting that whatever the specifications, whatever the process of manufacture, the railway must have good rails.

The end to be attained in any case is better rails, and we believe the opinion is growing among railway engineers that the best means for attaining this end is not to try to tell the rail makers how to do their work, but simply to insist that the results of it must be satisfactory and to try, by insisting on proper tests and guarantees of the quality of the product, to cause it to be made satisfactory.

A CORRECTION FROM MR. McNAB.

To the Editor of the Railway Age Gazette:

In the account of a conversation you had with me yesterday, in regard to the Panama Canal, and which is recorded in your Daily edition of March 19, I regret to note a typographical error which completely nullifies the sense of a paragraph.

On page 548, twenty-sixth line from the top, the word "not" should be the word "now," in order that the paragraph should read—"it is now quite clear," etc.

Will you please refer to this correction in your next edition? William McNab.

[Mr. McNab in his interview indicated that developments show that the United States government was justified in adopting the lock system, while the unfortunate typographical error to which he calls attention caused him to be incorrectly represented as saying that developments had not vindicated the policy adopted by the government.—Editor.]

PROGRAM.

Convention Program.

(Order may be changed by a two-thirds vote of the convention, or by time required for consideration of reports.)

Wednesday, March 20.

XIV.	Yards and Terminals	Bulletin 141
I.	Roadway	Bulletin 142
IV.	Rail	Bulletins 143, 144
XIII.	Water Service	Bulletin 142
VIII.	Masonry	Bulletin 143
XIX.	Conservation of Natural Resources	Bulletin 143
XI.	Records and Accounts	Bulletin 143
XVIII.	Electricity	Bulletin 143

Annual Dinner.

Reception at 6:30 p. m. in Francis I room, Congress Hotel; annual dinner at 7:00 p. m. in Gold room.

TICKETS FOR ANNUAL DINNER.

Tickets for the annual dinner, at $3.50 each, will be on sale to-day up to 5:00 p. m. in the lobby opposite the entrance to the Convention Hall.

AN INVITATION FROM THE ENGINEERS' CLUB.

The president and directors of the Engineers' Club have extended to the members of the American Railway Engineering Association who are attending the convention the use and privileges of the club. The new club house is located at 314 Federal street, just south of the Union League Club.

THE ANNUAL DINNER.

The annual dinner of the American Railway Engineering Association will be given in the Gold room of the Congress Hotel to-night. There will be a reception beginning at 6:30 in the Francis I room, adjoining the Gold room, and the dinner will begin promptly at 7:00 o'clock. Those who arrive after 7:00 o'clock will have difficulty in finding their places, as the numbers will be removed from the tables after the dinner begins.

W. F. SCHLEITER INJURED.

W. F. Schleiter, a former president of the Railway Appliances Association, is unable to be in Chicago at the time of this year's convention because of an injury received recently. While he was playing squash tennis he was hit in the face by a ball. His eyes were injured and he is now in a hospital in Pittsburgh, where he has undergone three operations.

CHANGES IN C., H. & D. ENGINEERING OFFICERS.

H. V. Hynes, division engineer of the Cincinnati, Hamilton & Dayton at Dayton, Ohio, has been appointed engineer of maintenance of way, with office at Cincinnati, Ohio. I. F. White, division engineer at Indianapolis, Ind., succeeds Mr. Hynes, and H. A. Cassil succeeds Mr. White.

C. W. P. RAMSEY PROMOTED.

C. W. P. Ramsey, division engineer of construction of the Canadian Pacific at Montreal, Que., has been appointed engineer of construction for the eastern lines of that road, with office at Montreal.

BLOCK SIGNAL COMMITTEE MEETING.

The Joint Committee on Block Signaling, of the American Electric Railway—engineering, transportation and traffic—Associations, held a meeting yesterday at 11 a. m., at the Congress Hotel. The full committee was present and a number of manufacturing companies were represented. Among the subjects considered were standard aspects for signals for the different conditions of electric line operation, and the extent to which these should be covered by the committee's recommendations.

J. M. Waldron, signal engineer of the Interborough Rapid Transit, New York, and C. D. Emmons, vice-chairman and general manager of the Chicago, South Bend & Northern Indiana Traction Co., South Bend, Ind., are co-chairmen of the joint committee, the former representing the Engineering Association, and the latter representing the Transportation and Traffic Association. The other members are: C. H. Morrison, signal engineer of the New York, New Haven & Hartford; John Leisenring, signal engineer and superintendent of overhead, Illinois Traction System; B. E. Merwin, general superintendent, Aurora, Elgin & Chicago, and C. F. Conn, vice-president and general manager, Lackawanna & Wyoming Valley Railroad Co.

ANNUAL MEETING OF RAILWAY APPLIANCES ASSOCIATION.

The annual meeting of the National Railway Appliances Association was held Tuesday morning at the Coliseum. President Robert E. Belknap's report for the year showed that the association had succeeded in collecting one of the largest exhibitions of railway material ever held under the auspices of the organization. Last year there was used 36,000 sq. ft. of space for exhibits in the Coliseum, whereas this year over 50,000 ft. in the Coliseum and Armory were occupied and from ten to twenty applications for exhibit space were refused on account of the lack of room.

Mr. Belknap also called attention to the new method of representation on the board of directors by the selection of two men for a three-year term, two men for a two-year term and two men for a one-year term. He stated that the steel companies and the steel and track appliances companies paid towards the cost of the exhibition approximately 43 per cent, signal appliances companies 12 1-3 per cent, miscellaneous exhibitors 29 1-3 per cent, exhibitors of gasoline engines, pumping machinery, coaling stations, etc., 8 per cent, and the exhibitors showing material of right-of-way excepting track material exhibitors 7 1-3 per cent. This would seem to justify, Mr. Belknap added, that the steel companies and track appliance companies have two representatives on the Board of Directors, the signal appliance companies one representative, the miscellaneous and right-of-way exhibitors two representatives, the gasoline engine companies one representative; and among the officers it would seem that there should be at least one representing the steel companies, one the miscellaneous companies and one the different railway publications who do so much to help the Board of Directors and to bring the devices of the exhibitors before the different railway officers and who in this connection are as important exhibitors as any.

The president of the association also pointed to the ever increasing interest on the part of railway officers throughout the country in the annual exhibition in the Coliseum. The secretary had received, he said, letters of praise without number from railway men who have seen the exhibition in previous years.

Treasurer John N. Reynolds reported receipts for the year ending April 12, 1911, of $21,463.14, disbursements, $20,235.95, leaving a surplus at the end of the year of $1,227.19.

Officers for the year were elected as follows:

President, A. P. Van Schaick, Lackawanna Steel Co., Chicago.

Vice-President, T. R. Wyles, Detroit Graphite Co., Chicago.

Treasurer, John N. Reynolds, Railway Age Gazette, Chicago.

Board of Directors, L. R. Ashurst, Jr., and W. H. Baldwin for one year, C. W. Kelly and N. M. Hench for two years and H. M. Sperry and P. W. Moore for three years.

FOUND.

Gold locket, with monogram on one side. Owner may recover by calling at the office of the Daily Railway Age Gazette and identifying.

H. W. Belnap, chief inspector of safety appliances, Interstate Commerce Commission, and James E. Howard of the Bureau of Standards, Washington, D. C., are in the city to-day for the purpose of attending the convention at the time of the discussion on the report of the rail committee.

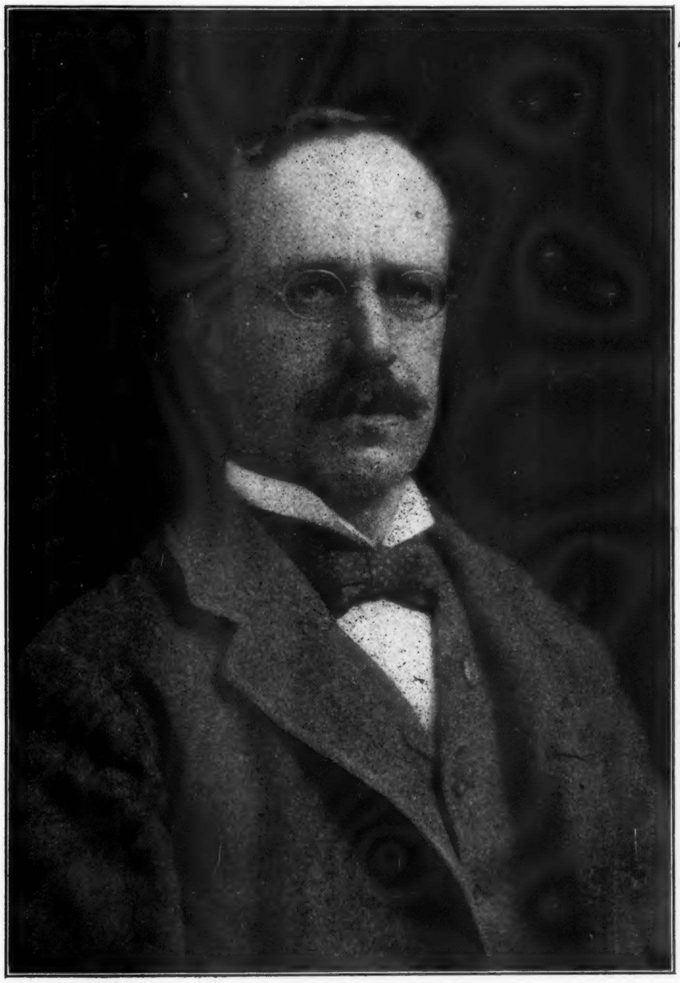
Proceedings.

The first session of the thirteenth annual convention of the American Railway Engineering Association was called to order at 9:20 a. m. on Tuesday, March 19, in the Florentine room of the Congress Hotel, by the president, W. C. Cushing, chief engineer maintenance of way, Southwest System, Pennsylvania Lines West.

The minutes of the last convention were approved as printed.

PRESIDENT'S ADDRESS.

At the last annual convention we numbered 967 members, honorary members and associates. During the year we have passed the 1,000 mark, although, naturally, our rate of growth has not been quite so rapid as in former years. As the date of our fiscal year has been changed from March to December 31, it is difficult to make exact comparisons. The largest number of accretions in any one year was 124, in 1901, while in 1904 we had 104, and in 1911, 98 new members. From last March to December 31, 1911, only part of a year, 37 new members have joined.



W. C. CUSHING, President.

During the first few years of the existence of the association a comfortable cash surplus was accumulated, but in the last three years the amount of printed matter issued has grown to such an extent that our expenditures have been in excess of our receipts, and the surplus has been drawn upon. The following table gives approximately the number of printed pages issued in each year since the beginning.

	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Totals
Constitution..	54	....	....	....	....	....	....	....	....	....	....	....	....	54
Bulletins.....	....	172	513	430	1124	794	1028	1074	848	1302	2234	1990	1470	12979
Proceedings..	....	244	825	598	602	1000	980	942	768	970	1778	1412	1982	12101
Manual.......	....	....	....	....	....	....	210	....	316	....	....	....	522	1048
Program.....	....	....	....	44	36	36	44	48	48	80	78	62	82	558
Miscellaneous.	....	....	....	....	24	8	....	....	....	26	34	34	32	158
Totals......	54	416	1338	1072	1786	1838	2262	2064	1980	2378	4124	3498	4330	27140

You will observe from this that during the last four years, 14,330 pages, or more than half the total, have been printed, exceeding the number issued in the preceding nine years.

It was clear to your Board, therefore, that either the printing bill must be reduced, or the revenue increased, or both.

So far as increasing the revenues are concerned, your Board has been unwilling as yet to recommend an increase in annual membership dues, but is arranging for the present to obtain additional revenue by employing an advertising agent to secure advertisements for the bulletins and program. It is estimated that this arrangement will net about $4,000 annually. The advertisements and methods of obtaining them will be closely supervised, but, nevertheless, the members of the Board are opposed to the principle, and would not resort to it except in a case of emergency. It is hoped that the plan can be abolished at a future date, as in the case of the American Society of Civil Engineers.

With reference to reducing the expenditures, the Board has given a great deal of study to the question during the past year, and has made some changes through the careful and energetic investigation of the publication committee and the secretary.

First in importance is the secretary's plan to avoid a reprinting of the reports for the proceedings, after the convention, by having a sufficient number of pages for the proceedings printed at the same time as the bulletins. The only disadvantage is that the discussions will be collected together at the end of the volume, instead of appearing at the end of the reports to which they refer, as in the past. This objection, however, was not considered of sufficient importance in comparison with the saving in printing, which is estimated to be about $1,000.

In addition to the above, but 10 bulletins a year instead of 12 will be issued, the May and June numbers being omitted. This is done because it is usually difficult to obtain articles for them, and the secretary is very busy during those months in preparing for the publication of the proceedings. It is hoped that it will result in their earlier appearance. Moreover, a reduction in the number of bulletins to be printed will be made, so that it will be necessary for members to bring their copies with them to the convention. Some extra

ones will be provided for those who prefer to purchase them at cost.

Further economy is expected in postal rates by obtaining the second-class mail privilege, application for which has been made to the Postmaster-General. All the prescribed details have been complied with, among which is the altered appearance of the cover of the bulletins. In this connection it was necessary to establish regular subscription rates for our bulletins, and we are also now advertising in them the established prices for all of our publications. The estimated reduction of expense for postage by this arrangement is about $500. It is of interest to know that we could not come under the regulations for this privilege till our association numbered 1,000 persons.

The question of the use of a thinner and lighter weight paper for our publications is now before the Board, and its adoption will probably result in some economy of postage expense. The transactions of the American Society of Civil Engineers are hereafter to be issued in one volume printed on India paper, but its use would not be economical for this association, because a special paper is required for the illustrations.

For a good while the Board of Direction realized that the number of subjects reported on by committees was apt to be too many for thorough discussion on the floor, considering the large number of standing committees, and introduced Rule 8-b for the preparation of committee reports, which limited the number to two for action by the convention. A large number of subjects has always been assigned each year, so that the committees could be collecting subject matter for other reports to be presented a year or more hence. When the increase in expenses became alarming the Board found it necessary to have the president issue a special circular to committee chairmen, calling attention to the necessity for enforcing the rule strictly this year. The several committees have responded heartily to the request, and the results of their conscientious and painstaking work is apparent in the valuable reports presented.

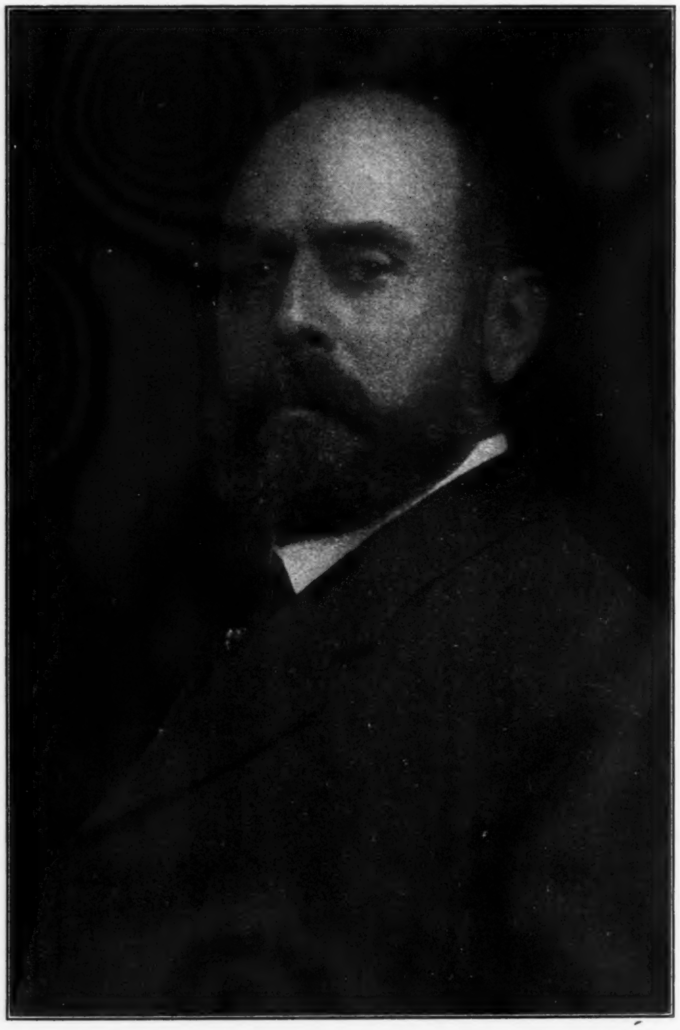
The ideal method of increasing our revenues (without resorting either to the augmentation of the annual dues or to advertising) would be to secure a larger membership, approximately double the present number, as the expense involved in issuing the bulletins and proceedings is not much more for a membership of 2,000 than for one of 1,000, while the revenue would be doubled. While we are pleased with the present number of members, yet it is evident that many who are eligible and who would be most desirable confrères have not yet identified themselves with the association.

In view of the unauthorized use of extracts from our proceedings for advertising purposes by commercial agencies, your Board arranged for copyrighting all of our publications in the United States. It was not expedient to do so in Canada.

At the last convention important changes in our constitution were adopted, among which were the shortening of the name, the establishment of a nominating committee, in order to place a larger share of the management in the hands of the members, and the addition of three members to the Board of Direction. During the past year it has been found desirable to make some changes in the "General Rules for the Preparation, Publication and Consideration of Committee Reports," and the "General Rules for the Publication of the Manual," in order to make the work of the association more expeditious and the papers and reports more valuable.

An invitation to send five delegates to the Third National Conservation Congress at Kansas City on September 25, 26 and 27, 1911, was extended to the association, and W. S. Kinnear, John V. Hanna, John R. Leighty, H. S. Moore and J. A. L. Waddell were named.

An invitation was issued to your association through the sub-department secretaries of the Department of Commerce and Labor to participate with them, the government engineers, and other engineering societies, in a conference for the purpose of unifying specifications for Portland cement, and the invitation was accepted, the matter being put in the hands of Committee VIII—Masonry. We were advised by



CHAS. S. CHURCHILL, First Vice-President.

the special committee of the departmental conference that, on January 8, 1912, all parties had agreed to the preliminary specifications, except there was a difference of opinion as to whether the Vicat or Gilmore needles should be used for determining the time of setting. On January 17, the committee of the American Society of Civil Engineers presented its final report, recommending the continued use of the Vicat needle for determining consistency and time of setting, which was accepted.

The assistant purchasing agent of the Isthmian Canal Commission has written our secretary for our rules covering creosote treatment of lumber and piling.

An invitation was also sent to this association to send a representative to the convention of the International Association for Testing Materials, to be held in September, 1912, and we will accept it.

Prof. W. F. M. Goss, dean and director of the University of Illinois, has tendered the use of data collected by the university and the assistance of its staff, in the work of Committee XVI—Economics of Railway Location.

In 1910 the amount of money contributed by the American Railway Association for experiments and other work in connection with the study of the rail problem was $6,213.57, while the amount authorized by that association for 1911 is $10,000. The results of the study are published in the bulletins as fast as completed. In this connection you are informed that the following letter has been received by your president from Judge Wm. J. Wood, chairman Railroad Commission of Indiana:

"The Railroad Commission of Indiana has about decided to commence a formal inquiry into the condition of steel now being put into the railroad tracks of this state, involving, of course, a comparison of the steel now being constructed and that formerly used on the railroads of this state.

"I understand that your association has had this matter up more than once, and I wish to have a conference with you about it in order, among other things, to have a suggestion from you, as to some person who could address a conference of railway managers and engineers, and other persons interested, held at Indianapolis under the direction of this commission. Will you be in Chicago this week? I will thank you to advise me in reference to this subject, and whether or not I could meet you if I shall come there for that purpose.

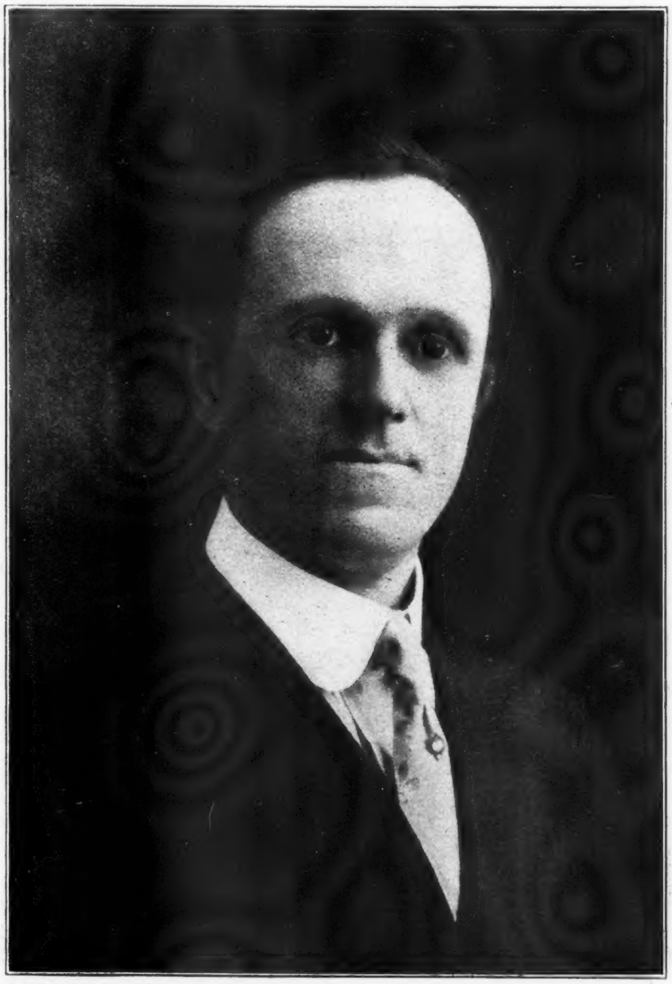
"Yours very truly,

(Signed) "W. J. Wood, Chairman."

Your president called upon Judge Wood, and explained to him the work which Committee IV—Rail has been doing.

At the meeting subsequently held on February 20, 1912, papers concerning the question of improvement of rail design and specifications were read by P. H. Dudley (by representative), Thos. H. Johnson and W. C. Cushing, and, in addition, addresses were made by F. A. Delano, E. J. Buffington, R. Montfort and Dr. Benjamin.

While speaking of the rail question, it is important to mention the admirable editorials on that subject in the Railway Age Gazette during the past few months, the specific numbers being those for October 6 and December 15, 1911, for January 12, February 9, February 16 and March 1, 1912. In two of them, those for October 6, 1911, and March 1, 1912, especial mention is made of the part taken in the study of the problem by our association.



EDWIN F. WENDT, Second Vice-President.

Your attention is called to the kindly expression of appreciation of our work in the editorial of the Railway and Engineering Review of October 28, 1911, page 940, and the statement on Railway and Engineering Literature, page 944. These words should be a stimulus to further effort.

In the "Regulations adopted on December 28, 1911, by the superintendents of buildings of all five boroughs of the City of New York," relative to reinforced concrete, clause No. 9 says that "Steel for reinforcement of concrete shall meet the requirements of the standard specifications for steel reinforcement of the American Railway Engineering Association."

In addition to the above, three authors of new books to be published have asked the authority of your Direction to embody information contained in our proceedings in their books.

From these instances it will be apparent that your work has attained such a value that information from it is now sought. The knowledge ought to spur us on to constant improvement.

During the past year the third edition of the manual has been issued. The comments on this volume by members and others have been quite complimentary. These compliments are deserved by the committees, Edwin F. Wendt, the reviewer, Prof. Pence, the editor, and your secretary, E. H. Fritch.

It is our sad task to announce that we have lost several of our fellow-members by death during the past year:

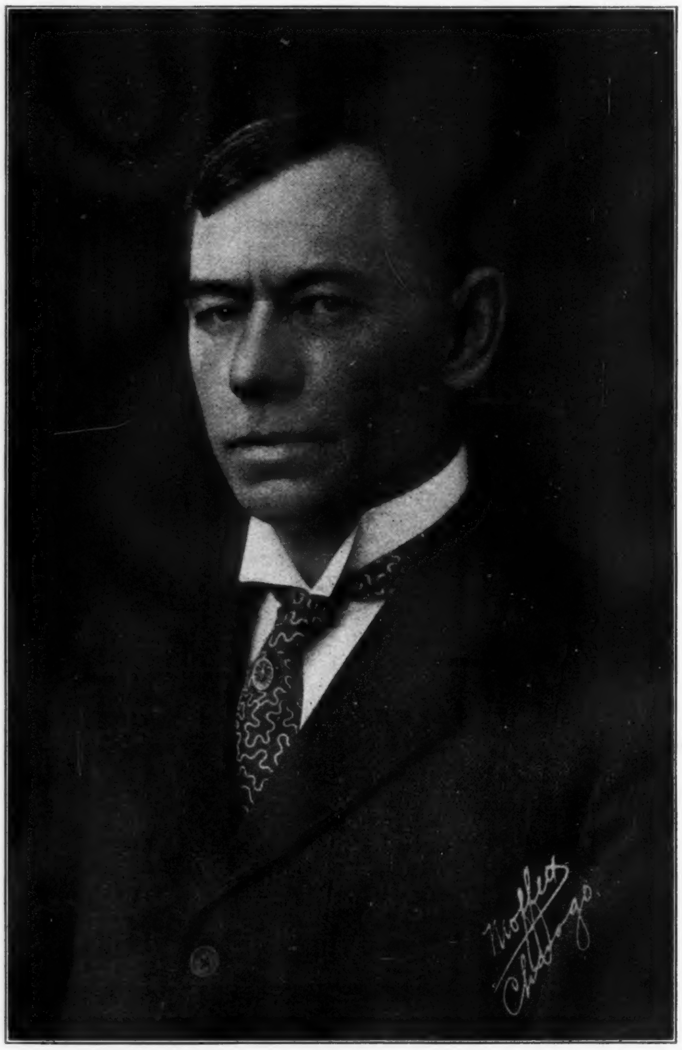
Benjamin Douglas, late tunnel engineer, Detroit River Tunnel Company, a charter member and an active worker on committees, was accidentally killed while inspecting a bridge in Brazil, South America.

W. D. Taylor, late chief engineer, Chicago & Alton, a brief sketch of whom was given in Bulletin 138.

Frank E. Simar, late division engineer, Canadian Northern, at Duluth, Minn.

N. P. Curtis, late instructor, University of Wisconsin, at Madison.

N. J. Gibbs, until recently engaged in construction work on the Panama Canal. He was accidentally killed at Tomkins Cove, N. Y.



E. H. FRITCH, Secretary.

H. Pierce, late engineer of construction of the Chesapeake & Ohio Railway.

Lewis Kingman, late office engineer of the National Railways of Mexico.

John S. Metcalf, president of John S. Metcalf Company, Chicago.

PROGRESS IN ENGINEERING WORKS.

The year 1911 has witnessed the continued progress, and in some cases the completion of vast works of engineers. Governments, whether federal, state or municipal, continue their works in times of depressed business as well as in prosperous times, and, therefore, the three greatest government undertakings, the Panama Canal, the Catskill Aqueduct and the Erie Canal, have been pushed steadily forward.

Of these the Catskill Aqueduct, estimated to cost $162,000,000, is of high importance, for it is expected to carry ultimately the water supply for 20,000,000 people. It is a stupendous undertaking, measuring 92 miles in length, from the Ashokan Reservoir in the Catskill Mountains to New York City, and, in time, to be extended into Brooklyn and Staten Island. The daily delivery of water is to reach 500,000,000 gallons. In addition to the 55 miles of cut and cover, there will be 24 grade tunnels, aggregating 14 miles, 6 miles of steel pipe siphons and 17 miles of pressure tunnels, 7 in number. The pressure tunnels are circular, about 14 ft. diameter, and the one of greatest magnitude and difficulty is that under the Hudson at Storm King Mountain, 1,150 feet below the surface of the ground. It was holed through last month in the presence of the Mayor of New York City and many others.

Another important government enterprise, which was brought to successful completion last March, is the Roosevelt Dam, in the canyon of the Salt river, about 70 miles east of Phoenix, Ariz., as it is for the purpose of impounding 418,000,000,000 gallons of water for irrigation. It is 276 ft. high, with a crest length of 1,080 ft. It was begun in September, 1906, and was estimated to cost about $3,850,000. Owing to its isolation, the cement used was manufactured at the site in a mill especially constructed for the work. The cost per barrel was $1.96, whereas, if shipped in, it would have been $9 per barrel.

Notwithstanding the depression in business, the year witnessed the continued progress, and also the completion, of some magnificent engineering works in the railway world.

The erection of the enormous and palatial station of the New York Central Lines in New York City has been finally started, after carrying on since 1903 a large amount of preliminary work of excavation, tracklaying and office building. This work has embraced about 3,000,000 cu. yds. of rock excavation, carried on under great difficulties, about 250,000 cu. yds. of concrete and about 60,000 tons of steel.

The tracks are on two levels, the suburban, 20 in number,

about 49 ft. below the street level, and the express or through tracks, 22 in number, 20 to 25 ft. above them.

On June 4, 1911, the large new passenger station of the Chicago & Northwestern Railway in Chicago, costing about $24,000,000, was opened for service. Its style is Italian Renaissance, and it is built of gray Maine granite. The train shed has 16 tracks, and belt conveyors are used for conveying some of the incoming mail.

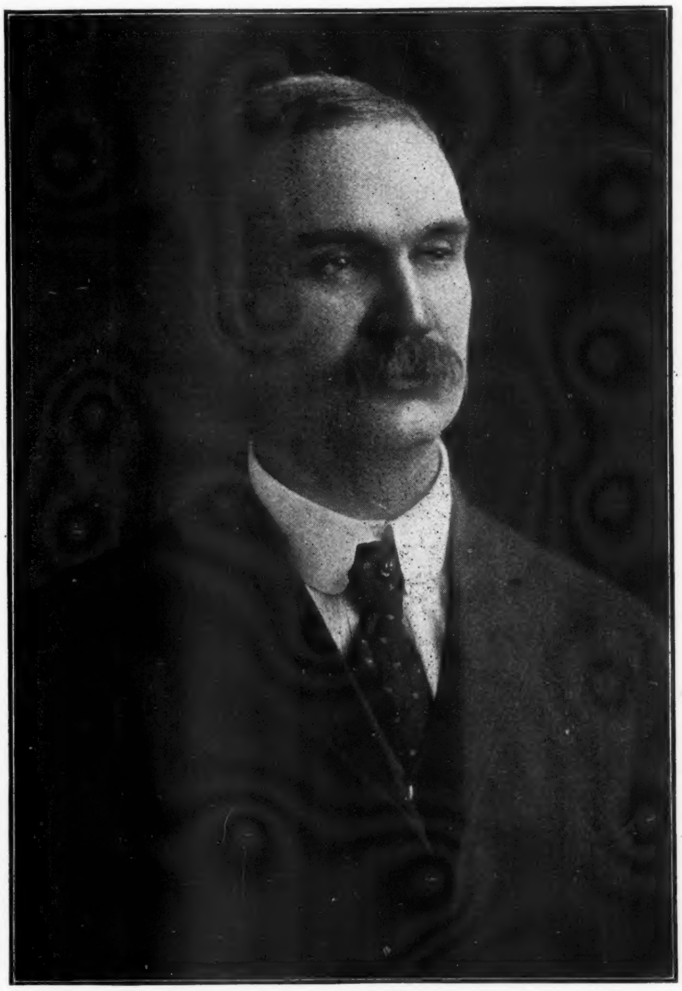
Identified with the name of one man, Henry M. Flagler, an enterprise entirely different from any other was brought to successful completion in the last week of December, 1911, so far as the placing of the last batch of concrete was concerned. This is the famous ocean railway from Miami to Key West in Florida, 154 miles, of which 74 miles are on land, 25 miles on swamps and 55 miles over water or on the long line of islands that make up the Florida Keys. There are about 500 reinforced concrete segmental and semicircular arches from 45 to 60 ft. span. The longest viaduct is 10,500 ft., between Long Key and Conch Key. It is a wonderful piece of work and several disasters from storms during the construction have been experienced. It was opened for public service, January 22, 1912.

the Paulins Kill. The first is 1,540 ft. long and 64 ft. high, and consists of five spans of 150 ft., two of 120, one of 53 and one of 50½ ft. The Paulins Kill viaduct is 1,100 ft. long and 117 ft. high, and has five spans of 120 ft. and two of 100 ft.

The Southern Pacific also completed a line and grade change up the western slope of the Sierras from Rocklin, Cal., to Colfax, 30.8 miles, on a 1.5 per cent grade. There are 17 tunnels on the line.

The Galveston causeway, estimated to cost $1,615,000, was begun in 1909, and is a structure a little more than 2 miles long, connecting Galveston island, on which the city of that name stands, with the mainland, its main feature being a reinforced concrete viaduct 2,455 ft. long, consisting of twenty-eight 70-ft. arch spans and a lift span with a clear waterway of 109 ft. The viaduct portion is 66 ft. wide, and carries 2 railway tracks, 1 electric railway track and a roadway of 19 ft. clear width. On the causeway embankment approaches there are more tracks, and the roadway widens to 40 ft. About 9,808 concrete sheet piles, making a continuous strip 35 miles long, were required.

The work of introducing electric power on steam railroads was continued, although in this case, the Hoosac Tunnel, it



GEORGE H. BREMNER, Treasurer.

Another great railroad enterprise, estimated to cost $9,500,000, is the line and grade improvement of the Delaware, Lackawanna & Western Railroad, between Slateford, Pa., and Hopatcong, N. J., which was opened for traffic Christmas, 1911. The old line was shortened from 39.57 miles to 28.45 miles, the grade reduced from 1.14 per cent to .55 per cent, and the curvature from 6 deg. 54 min. to 2 deg., except in the case of one of 3½ deg., saving 1,500 deg. of central angle. It was an unusually bold piece of work, and of great magnitude. The grading consisted of 7,890,000 cu. yds. of earth excavation, 6,502,000 cu. yds. of rock excavation, and 16,000,000 cu. yds. of embankment. The Pequest fill, containing 6,625,650 cu. yds. of material, is probably the largest railroad embankment ever constructed, being 3 miles long and from 75 ft. to 110 ft. high. The total quantity of concrete is 266,900 cu. yds., and two of the bridges are magnificent reinforced concrete arch viaducts, one over the Delaware river, and the other over

was of but limited extent. The work was begun October 3, 1910, and finished May 18, 1911, at a cost of 1¼ million dollars. The electric system is the same as used by the New York, New Haven & Hartford, and the zone extends from a small tunnel just west of the North Adams station to a point just east of the Hoosac Tunnel station, 21 miles of track being electrically operated. The tunnel is 4.75 miles long, and was opened in 1875. But lately the New Haven company has made known its plan to change the main line from Stamford to New Haven to electric traction at an early date, at an estimated cost of $7,000,000.

Last April it was announced that a beginning had been made on the last of the $160,000,000 worth of improvements started in 1903 by the Pennsylvania Railroad, viz.: the New York Connecting Railway, which will link the Pennsylvania and New Haven roads together. This link will be 12 miles long, the principal feature of which will be the four-track bridge

from Astoria on Long Island over Hell Gate, Ward's and Randall's Islands, to Mott Haven or Port Morris. The bridge over Hell Gate and its approaches will be about 3 miles long, and will be of most massive construction, costing about $20,000,000. The main span is a steel arch 1,020 ft. long and 140 ft. above mean water level, making an imposing gateway for the East River entrance to New York Harbor.

Great engineering works are not confined to this country. The Swiss railway engineers have been obliged, by the rugged nature of their country, to resort to long and ingenious tunnel building, in order to prevent their land from becoming a barrier to international transportation. The world's longest tunnels have been built there, the Simplon, 12.4 miles long; the St. Gothard, 9.5 miles long, and the past year witnessed the piercing of the third longest, the Loetschberg, 9 miles long. They also have the first, Mont Cenis, 7.5 miles long, begun in 1857, and the Arlberg, 6.5 miles long. In the case of many of these tunnels, gain in elevation in short distances has been obtained by the use of the spiral, making the journey over the railway most fascinating, interesting and beautiful.

The Loetschberg tunnel is built to put the capital, Bern, on the main line from Milan, Italy, to Paris and Calais in France, while at the same time the distance is shortened by 80 miles to 675 miles. It was originally planned to be straight, but a disastrous inrush of water from the Kander river, burying 25 men, compelled the contractors to wall it up and build a detour with two short curves. The record of tunnel driving has been made in this work, a start being made November 1, 1906, while the headings met March 31, 1911.

The increased daily rate of tunnel driving due to improved methods and machinery is well illustrated in these Swiss tunnels.

The rate at the Mont Cenis, begun in 1857, was 7.75 ft. per day, two headings.

The rate at the St. Gothard, begun in 1872, was 18 ft. per day, two headings.

The rate at the Arlberg, begun in 1880, was 27.25 ft. per day, two headings.

The rate at the Simplon, begun in 1893, was 36 ft. per day, two headings.

The rate at the Loetschberg, begun in 1906, was 29.5 ft. per day, one heading, while a maximum for one day with one heading was 36 ft.

The Panama Canal continues to be the most costly and most stupendous enterprise now in progress, and its engineers are earning a monument of fame for themselves. The special commissioner to "The Engineer" of London, Mr Percy F. Martin, F. R. G. S., who visited the canal in 1910, makes this statement in the issue of June 9, 1911: "When the canal shall be pronounced completed, and the huge lock gates swing open for the first time to receive the earliest vessel, a chorus of acclamation and congratulation will ascend such as probably no human achievement has ever yet called forth. And justifiably so."

In Engineering News for February 17, 1910, the following appeared:

THE COMPLETE ENGINEER OF 300 YEARS AGO.

"Wrapped in the stoutest of manila paper and deposited on the shelves of the library of the American Society of Civil Engineers is a book, the gift of W. A. Haven, M. Am. Soc. C. E., which is probably one of the earliest of printed books in the English language treating of the art or science of engineering. On a curiously embellished title page is the following caption:

"'A Practical Abstract of the Arts of Fortification and Assailing * * * Written for the benefit of such as delight in the Practice of those Noble Arts. By David Papillon Gent: * * * London Printed by R: Austin and are to be sould at the south side of the Exchange & in Popes head Alley 1645.'

"Engineering in that day, and for a century or so after, was entirely a military accomplishment, and so the science discussed by the author did not embrace any of the civil arts which were later a part of the engineer's knowledge, but prefacing the more serious work there is a chapter on (The True Character of a Complete Engineer) which will appeal even to the modern engineer. Especially will the last paragraph of this chapter touch a tender spot in the heart of every engineer who has had to argue against all reason with the lawyer, director or business man who can see in engineering only a superior sort of craftsmanship which, in its fundamentals, should be knowledge easily deduced by themselves. The major portion of this first chapter follows:

"'OF THE TRUE CHARACTER OF A COMPLETE ENGINEER.

"'(1) He is to be religious for the fear of the Lord is the beginning of wisdom.

"'(2) He is to be a souldier for none can better judge of the sufficiency or insufficiency of fortification. * * *

"'(3) He is to be a traveller; for he that hath not seen variety of works, and the excellency of foreign fortifications, cannot perceive the defects of ours, nor give directions to rectify them.

"'(4) He is to be well versed in the arithmetike for his calculations; in the geometry, for the setting out of all superficies; in the architecture, for to direct all manner of artificers; and in the other parts of the mathematikes, for the taking of distances, depths and elevations, and for the inventing and contriving of all manner of engines and machines.

"'(5) He is to be wise in all his proceedings, punctual in all his promises, careful and diligent in his calling, and rather inclined to austerity with lenity, or otherwise he will never be respected, served or obeyed.

"'(6) He is to be of solid judgment and quick of apprehension to judge aright of the defects and advantages of places. * * * He is not to give account of his actions to any, but to the generall, or to the lieutenant generall of the Ordnance if he be in an army, or in a garison, only to the grand committee, and to the governour; and as for all other kinds of men, inhabitants, souldiers or officers; he is not bound to expostulate the case, if they demand of him reasons for anything he directs or commands to be done; neither ought he if he regards his reputation, and makes conscience of his ways, to comply * * * with the humour of the greatest in authority, or be led to assent to any resolution, that is against the maxims of his art, by the logical and sophisticall reasons and arguments of scholars or churchmen; for some of them are now a days overbusie in things that go beyond their element, and endeavor to over-sway artists by rhetorike, considering not that their reasons are no reasons at all to the reasons of Art. And this last quality is the essentiall part of a good Engineer; for all the other are but to small purpose without this.'"

Fellow members: Many of the engineers engaged in the huge enterprises briefly outlined in the foregoing pages, and in other work, too, not mentioned, will measure up with "The Complete Engineer of 300 Years Ago."

Reports of Secretary and Treasurer.

The secretary's report is published on another page of this issue.

The treasurer made the following report:

Balance cash on hand March 15, 1911....		$13,216.62
Consisting of:		
Ten railroad bonds, as follows: Four St. Louis Southwestern bonds, par value $1,000 each, at cost.........	$ 3,319.31	
Six L. S. & M. S. Ry. bonds, par value $1,000 each, at cost.......	5,660.25	
Cash in bank......................	4,237.06	
Total	$13,216.62	
Receipts from all sources, March 16, 1911, to December 31, 1911............		$23,716.69
Receipts from all sources, January 1, 1912, to March 15, 1912...............		10,538.44
Total receipts for the year.........		$34,255.13
Expenditures, paid on audited vouchers:		
March 16, 1911, to December 31, 1911..	$25,602.96	
January 1 to March 15, 1912..........	3,766.70	
Total for the year................		29,369.66
Balance to credit..................		$ 4,885.47
Less proceeds from sale of four L. S. & M. S. bonds.......................		3,797.33
Net excess of receipts over expenditures		$ 1,088.14
Balance, March 15, 1912:		
Cash in bank.......................		$ 8,836.43
Cash on hand, checks, etc............		286.10
Four St. Louis S. W. bonds, at cost..		3,319.31
Two L. S. & M. S. bonds, at cost......		1,886.75
Total cash assets.................		$14,328,59

The secretary reported the following details of receipts for the year:

	March 16, 1911, to December 31, 1911.	January 1, 1912, to March 15,1912.	Total.
From members (dues, etc.)....	$ 5,274.48	$ 8,567.35	$13,841.83
From others (sales of publications, advertising, etc.)......	6,853.59	1,394.91	8,248.50

From American Railway Association, account Rail Committee expense	6,495.57	508.56	7,004.13
From interest	295.72	67.62	363.34
From loan	1,000.00	....	1,000.00
From proceeds of sale of bonds	3,797.33	....	3,797.33
Total	$23,716.69	$10,538.44	$34,255.13

RULES AND ORGANIZATION.

Last year's report of this committee embodied revisions of the rules as then published in the manual and additional rules of the same general character, all relating to the government of employes of the maintenance of way department.

For this year's work the committee was instructed to: Continue the compilation of rules for the government of maintenance of way employes, and to formulate rules in the nature of specifications or instructions regarding the conduct of work, making use of the recommendations of the various committees dealing with these subjects and of the best practice of railway companies, as embodied in their books of rules.

Some progress has been made with rules falling under the first of the instructions, but this year's report deals only with the work falling under the second of the instructions.

J. O. OSGOOD,

Chairman Committee on Rules and Organization.

The committee recommends that no change be made in the General Rules for the Government of Employes of the Maintenance of Way Department heretofore adopted by the association, and that to the rules heretofore adopted by the association be added instructions, as follows:

Cross-Sections.

(1) The roadbed, ballast and track shall conform to the standard plans. No changes in the sections shown shall be made without proper authority. (It is understood that cross-sections for wet cuts will be included in the standard plans.)

Drainage.

(2) All ditches, including intercepting ditches on the upper side of cuts, must be kept clean.

(3) Where heaving or wet spots develop, special drainage shall be provided.

Ballasting.

(4) Before re-ballasting track, line and grade stakes shall be set by the engineer. All unsuitable material shall be removed and the roadbed widened to proper section, the waste material being used to widen banks or otherwise, as may be directed.

(5) Track must be kept in good line and surface while ballasting, open track avoided as far as practicable, and such track carefully watched.

(6) After ballast is distributed it shall be trimmed, and the track lined and surfaced to conform to the standard plans.

(7) Where track is bonded, ballast must be kept at least one inch below the base of rail. At road crossings, platforms, etc., where this is not practicable, only clean gravel or rock ballast shall be used.

Ties.

(8) Ties stored along the right-of-way shall be piled to conform to the standard plan. (The standard plan should show the minimum distance to the nearest rail.)

(9) The ties in track must be inspected at stated times each year, and those which will not last until the next inspection marked for renewal.

(10) The renewal of ties shall be started when directed by the ....(Title)......... When ties are being renewed, the line and surface shall be corrected and ballast trimmed.

(11) All defective ties removed from track shall each day be placed for burning or loading on cars.

(12) The ....(Title)........ shall frequently inspect ties removed from track to see if any have been removed which might have remained in the track with safety until the next inspection.

(13) Ties shall be spaced according to the standard plans. All ties shall be placed square to the line of rails. The outside ends on double tracks, and the ends on one side throughout on single track, must be lined parallel with the rail.

(14) The heart side of ties must be turned down. The largest and best ties shall be selected for use at joints. Twisted or badly hewn ties must not be notched, but the bearings must be made true with the adze.

(15) Whenever spikes are drawn from ties, wooden tie plugs must be driven into all holes except in ties which are to be renewed that season. In replacing spikes they should be driven into the plugs.

Rail.

(16) In unloading rails from cars they should be skidded or otherwise carefully lowered to avoid injury. Where it is necessary to drop them, both ends must be dropped together and the greatest care taken to avoid their falling on hard and uneven surfaces.

(17) The bottom of the new rail and the bearing surface of the tie shall be cleaned before the new rail is laid.

(18) When replacing rail with rail of the same section, only two rows of spikes shall be drawn; in replacing with rail of a different section, three rows of spikes shall be drawn.

(19) In laying new rail, standard expansion shims shall be used. The temperature of the rail shall be taken by placing the thermometer on the rail. The openings between 33 ft. rails shall be as follows:

Temperature (Fahrenheit).	Amount of Opening.
—20 to 0 deg.	5/16 in.
0 to 25 deg.	1/4 in.
25 to 50 deg.	3/16 in.
50 to 75 deg.	1/8 in.
75 to 100 deg.	1/16 in.

Over 100 deg. to be laid close.

The rail should be laid without bumping and, when practicable, laid rail by rail.

(20) The rails shall be brought squarely into line and at least two bolts tightened before spiking. All joint bars shall be securely fastened with the full number of bolts, tightening those at the center first. At permanent connections of rails of different sections step chairs and off-set splices must be used.

(21) All spikes must be driven vertically with the face in contact with the base of the rail. They should not be straightened while being driven. The rail must be full spiked and the spikes staggered so that the outside spikes shall be on the same side of the tie and the inside spikes on the opposite side.

(22) In making temporary connections in main tracks an old rail should be cut and fastened to the new rail, using compromise joints when necessary. Switch points shall be used for this purpose only during the presence of the track foreman.

(23) After new rail is laid the track must be lined and surfaced.

(24) All kinked or crooked rails must be straightened before being laid; if bent in service they must either be removed or straightened.

(25) Rails for curves of 2 deg. and over should be curved before being laid. In curving or straightening rails, the rail bender must be used.

Surfacing.

(26) When surfacing (picking up low points or other low places), the general level of the track must not be disturbed.

The report is signed by Jos. O. Osgood (C. R. R. of N. J.),

chairman; G. D. Brooke (B. & O.), vice-chairman; F. D. Anthony (Q. M. & S.), C. Dougherty (C. N. O. & T. P.), F. P. Gutelius (C. P.), Jos. Mullen (C. C. C. & St. L.), S. E. Coombs (N. Y. C. & H. R.), J. B. Carothers (B. & O.), Kenneth Hanger (C. R. I. & G.), J. A. Gordon (C. G. W.), J. B. Dickson (Erie).

Discussion on Rules and Organization.

In the absence of Mr. Osgood, the report was presented by F. D. Anthony (Q. M. & S.).

Mr. Anthony: It is the opinion of myself and of one other member of the committee that the rule in paragraph 6 is not right. Ballast is usually distributed in anticipation of a lift. It seems to me the lift is the first thing after the distribution of the ballast, and I would suggest this reading: "After ballast is distributed and the track lifted, the track should be lined and surfaced and the ballast trimmed to conform to standard plans."

A motion to that effect was seconded and carried.

E. E. R. Tratman (Eng. News): I move that the word "electrically" be inserted before "bonded" in paragraph 7. We all know what that word "bonded" means, but as these are rules to be sent out for track men and track officials, I think that should be explained more fully.

The President: The acting chairman says there is no objection to making that change.

H. M. Church (B. & O.): I would like to change the last word in the last sentence of paragraph 10, so that it shall read, "unsuitable material removed and ballast trimmed."

Mr. Anthony: There is no objection to that.

Mr. Tratman: I think paragraph 12 could be simplified a little in the second line, by saying "if any of them have been removed," instead of "if any have been removed which might have remained."

Mr. Anthony: There is no objection to that correction.

W. L. Webb (C. M. & St. P.): I think the last sentence of paragraph 14 is a little indefinite. It says: "Twisted or badly hewn ties must not be notched, but the bearings must be made true with the adze." I suppose what is intended is that ties shall be hewn so that there is a good surface, instead of being a mere notch. It seems to me the reading could be improved a little, to bring out the real meaning, for even a notch may have the surface true, which evidently is not what is intended. It might be made to read, "Twisted or badly hewn ties must not be notched, but must be hewn for the full length of the tie," or words to that effect.

Mr. Anthony: The intention of the committee is that they shall be properly adzed, but not notched.

E. R. Lewis (M. C.): I assume we all realize the importance of the proper method of laying ties. The first sentence of this Rule 14 reads: "The heart side of ties must be turned down." As far as I know, that is the dogma of the railway rules. These are positive orders, leaving absolutely nothing to the judgment of practical track men who may have been laying ties for fifty years. This rule vitally concerns the whole track structure. I opposed this rule because I believe it is wrong and I do not believe it can be done. I have investigated many hundreds of thousands of ties with this point in view, and on the very roads whose rule books contain this rule the ties in many cases are not laid according to the rule. The definition of a tie given in the manual is: "The tie is that transverse member of a railway track which supports the rails and by means of which the rails are retained in position." The purpose mentioned in this definition will not be best served by placing the tie heart side down. The heart wood of the tie is denser than the sap wood. Its cells are thicker and have less moisture when the wood is green. Therefore, it loses less moisture when the wood is cured. The cells of the sap wood are thinner than the cells of the heart wood, and the cells are larger. Sap wood is not so dense, and cannot hold the spike as well. With the sap side up, only the point of the spike reaches the densest wood. In the less dense sap wood the neck of the spike has a tendency to work out of gauge and move a little more than the point does. What we especially want is to get the neck of the spike, that part of the spike nearest to the rail, where it will do the most good and hold the gauge best. When any timber starts to check, it checks from the sap side first, because the sap side loses sap first, loses more of it, and allows the shrinkage to take place more quickly and it shrinks more than the heart side. The heart wood being denser contains less moisture, and, absorbing less moisture, is longer lived than the sap wood. The sap wood will dry out, check and warp away from the heart. This applies to all sorts of timber. In the town where I live, we cut something like one hundred million feet of timber every year, and every lumberman in Saginaw Valley has told me that timber will warp away from the heart; every lumberman in every other valley will tell you the same thing. Therefore, I say that the tie should be laid heart side up, because any shrinking and warping of the tie warps away from the heart, and the heart is the convex side. Now, you cannot get a good bearing for a tie unless you lay it with the convex side up. If you lay it with the concave side up, you have a rocking chair and not a railway. Any good, practical laborer will tell you to lay a tie "belly up." I think that 90 per cent. of the ties that are laid in the track are perceptibly warped or crooked. They are not precisely straight. There is a choice of bearing. I do not think any track foreman ever should allow a tie to be put in the track without choosing the bearing and the side which should go up, irrespective of sap side or heart side. He must get the convex side up.

According to statistics, 80 per cent. of the 125,000,000 ties bought by the railways of the United States in 1911 were hewn ties. The hewn tie is a pole tie. A man going into the business of making ties is not going to pick out timber which has to be split and worked out on four sides. He picks out pole timber that requires working on only two sides. The other timber is worked up into something else. In making sawed ties, all the boards possible are made of the outside of the log, which leaves a box heart tie. You can put the heart side up or the heart side down. The same applies to the pole tie. Besides being wrong in principle, I believe this sentence is unnecessary. Only 5 or 10 per cent. of the ties have the heart on one side, and even that 5 or 10 per cent. ought not to be laid wrong side up. I move that this part of the rule be made to read: "Ties must be laid so as to obtain the best bearing."

Robert Ferriday (C. C. C. & St. L.): I second the motion.

The motion was carried.

L. A. Downs (I. C.): I think we should make some reference to the use of treated plugs in treated ties by adding to paragraph 15, "When spikes are withdrawn from treated ties, plugs of treated material should be used."

Mr. Anthony: That rule is general. It does not refer to either treated or untreated ties. These rules may be supplemented by such special rules as local conditions may require.

Mr. Lewis: I move that the last sentence of paragraph 16 be eliminated. I think if we say, "In unloading rails from cars they should be skidded or otherwise carefully lowered to avoid injury," we have said all that is necessary.

Mr. Downs: I second the motion.

H. T. Porter (B. & L. E.): As I understand it, the second sentence is provided for those cases where they have not the equipment to carefully lower the rails. On a sandy roadbed, with reasonable care, you can drop the rails without danger of breakage, and I would judge that a very large percentage of the rails in this country are unloaded without their being skidded or lowered carefully with some device.

The motion was lost.

Mr. Anthony: A correction to strike out the word "new" in the first sentence of paragraph 17 has been accepted.

Mr. Ferriday: In clause 18, I don't think the section should determine whether two rows of spikes shall be left or three rows. It depends upon certain parts of the section. I know that in a great many cases but two rows of spikes are drawn, in laying rails of different section. It depends upon the gauge of the track, the difference in sections, the width of the base and the width of the head. I move to add, after that paragraph, "if necessary."

The President: That is accepted by the committee.

Mr. Tratman: In paragraph 20, the terms "step chairs" and "offset splices" are used. In the 22d, the term "compromise joints" is used. Those are three names for one device, and I think in No. 20 the words "compromise joints" should be used.

The President: The committee will accept that suggestion.

Mr. Downs: I move that we eliminate the last sentence of paragraph 22.

Motion seconded and carried.

L. W. Baldwin (I. C.): Paragraph 24 says, "If bent in service, they must either be removed or straightened." After straightening, I think it is unsafe to lay them back in the main track.

Mr. Anthony: This does not say they shall be laid back in the main track. They may be laid in the siding.

Hunter McDonald (N. C. & St. L.): Does Mr. Baldwin mean that a rail is necessarily unsafe because it has been straightened? If that is true, the curving of rails is bad practice. I recall having straightened as many as 2,000 rails, some of which are still in service after twenty years.

Mr. Baldwin: It is true that curving a rail is bending it, but when curved by the roller rail bender the process is very gradual. I have seen cases where service bent rails

in the main track were taken out and straightened and then relaid in the main track, and I have found they were liable to breakage at the point where that straightening had been done. It seems to me it is not a safe practice to take a service bent rail and straighten it and put it back into the main track, under heavy service.

Mr. Porter: A service bent rail means a rail that is bent vertically. Any power that is sufficient to bend it is liable to damage the structure of the rail, but a rail can be bent sideways or horizontally, because, on account of the section, it is not so stiff in that direction. So it can be bent sideways and straightened again and put back in the track without taking any great chances. I don't think this is intended to refer to service bent rails. It means rails bent out of line.

C. A. Morse (A., T. & S. F.): It seems to me these rules are rather too general, for the reason that we have first, second, third and fourth class track. We build light branches for the development of a country and lay most anything on them. To make a rule that you can't straighten a bent rail is impracticable, because none of us follow it.

Mr. Baldwin: I think after a rail has been kinked, as referred to in the first part of this paragraph, and then straightened, it should be treated as if it were a second quality rail.

Mr. Lewis: I move that Rule 24 be adopted.

Motion seconded and carried by a rising vote; affirmative, 41; negative, 24.

H. E. Hale (Mo. Pac.): I move that paragraph 25 be changed to read 4 degrees instead of 2.

Mr. Morse: The rule says that the rail bender must be used. I understand there are some roads in the country that have not been using a rail bender on the outside rail. They curve the inside rail and then spring the outside rail to gauge. We have done that in a few cases and have found it very satisfactory, rather tending to get away from the short kinks that are there, whether you can see them or not, when the rail bender is used.

Motion seconded and carried.

Mr. McDonald: Does the manual show whether any action has been taken on this matter in the past? I think it has already been fixed at two degrees.

The President: A hasty examination of the manual does not show any action to have been taken, but the chair rules this will be a matter for the editor of the manual to take care of. Paragraph 25 has, therefore, been changed to read "four degrees" instead of "two," unless there is a vote requested.

J. G. Sullivan (C. P. R.): The word "the" in that paragraph would lead one to believe that the committee had a special bender in mind. I would suggest "a rail bender."

The President: The committee accepts that.

J. B. Berry (C., R. I. & P.): I move to strike out everything in the parentheses in paragraph 26. There cannot be two different kinds of low points. Surfacing means picking up the track, and it is covered by the balance of the rule.

The President: The committee accepts that.

Mr. Morse: Paragraph 26, as amended, would read, "When surfacing, the general level of the track must not be disturbed." I think that is misleading. If you are surfacing to face, you certainly must disturb the surface of the track, and any track has got to be surfaced to face occasionally.

Mr. Porter: I would like to offer an amendment to 26, as follows: "When picking up low joints or other low places, the general level of the track must not be disturbed."

Motion seconded.

Mr. Porter: The word "surfacing" is a general term and applies to lifting track, when you are simply lifting one side or lifting joints, or when you are lifting out a foot in order to put on new ballast. This clause, however, is to warn the foreman that when he is simply picking up low joints and other low places they must not disturb the general surface of the track. That is a source of a great deal of difficulty on track maintenance. Old experienced foremen can often go through a section, in the spring and early summer, and put it in first-class shape with little or no effort, whereas a younger foreman, when it is only necessary to pick up joints at low places, may do more harm than he does good by attempting to do what this rule says he must not do, namely, disturb the general level of the track.

C. H. Stein (C. R. R. of N. J.): This reads, "when picking up low points"—a typographical error, no doubt. I think this would read better, "when picking up joints or other low places the general level of the track must not be disturbed," and not duplicate the word "low," because that is very clear by inference.

Mr. Porter: I accept that.

C. H. Ewing (A. C. Ry.): I hope the motion will not carry. I think all of us know that surfacing simply covers picking up low joints and low spots. Raising track is an entirely different proposition; so that the rule as agreed to by the committee should stand.

Motion carried.

A motion was made and carried to adopt the rules as amended.

SIGNALS AND INTERLOCKING.

Four subjects were assigned for consideration:

(1) Continue investigation of outline and description of a comprehensive and uniform signal system, suitable for general adoption, conferring with proper committee of the American Railway Association.

(2) Revise mechanical interlocking specifications, and include wrought-iron pipe as well as steel.

(3) Revise electric interlocking specifications and submit statement of the results from experience.

(4) Report on the effect of treated and metal ties on track circuits.

Last year the committee presented revised specifications for various kinds of insulated wire, which the association adopted. In order to bring these specifications into conformity with those adopted by the Railway Signal Association, a new insulation resistance table is herewith submitted.

A. H. RUDD.
Chairman Committee on Signals and Interlocking.

CONCLUSIONS.

(1) The following table of insulation resistances in megohms per mile at 60 deg. Fahrenheit for the various thicknesses of insulation in fractions of an inch and the various sizes of wire is made a part of the specifications for mineral matter, rubber compound, insulated signal wire for current of 660 volts or less, appearing in Vol. 12, Part 1, pp. 101 to 104, inclusive, and the insulation resistance in megohms per mile, shown on page 108, is revised to conform with this table.

B. & S. G.	3/64	2/32	5/64	3/32	7/64	4/32	5/32	6/32	7/32	8/32
0	....	....	900	1100	1200	1300	1500	1800	2000	2200
1	....	....	1000	1200	1400	1500	1800	1900	2200	2400
2	....	1000	1100	1400	1500	1600	1900	2200	2300	2600
3	....	1100	1200	1500	1600	1800	2000	2300	2600	2700
4	....	1200	1400	1600	1800	1900	2200	2400	2700	2800
5	....	1300	1500	1700	1900	2000	2300	2600	2800	3100
6	....	1400	1600	1800	2000	2200	2600	2800	3100	3400
8	1400	1600	1900	2200	2300	2600	2800	3200	3500	3800
9	1500	1800	2000	2300	2600	2700	3100	3400	3600	3900
10	1600	1900	2200	2400	2700	3000	3200	3600	3900	4200
12	1800	2200	2500	2800	3100	3200	3600	4000	4300	4600
14	2200	2600	2800	3200	3500	3600	4200	4400	4800	5100

(2) The above table of insulation resistances in megohms per mile at 60 deg. Fahrenheit for the various thicknesses of insulation in fractions of an inch and the various sizes of wire is made a part of the specifications for mineral matter, rubber compound, insulated aerial braided cables for current of 660 volts or less, shown on pp. 105 to 109, inclusive, of the same volume, and the insulation resistance megohms per mile, shown on page 108, is revised to conform thereto.

(3) The above table of insulation resistances in megohms per mile at 60 deg. Fahrenheit for the various thicknesses of insulation in fractions of an inch and the various sizes of wire is made a part of the specifications for mineral matter, rubber compound, insulated, lead-covered, armored submarine

cables for 600 or lower voltage service, shown on pp. 110 to 114, inclusive, of the same volume, and the insulation resistance megohms per mile, shown on page 113, revised to conform thereto.

The committee does not report this year on subjects Nos. 2, 3 or 4. It reports on Subject No. 1 as follows:

UNIFORM SIGNALING.

This subject was referred to the Committee on Transportation of the American Railway Association by the 1910 convention. In 1911, progress was reported.

The amended report of the Committee on Transportation, accepted by the American Railway Association, as information, May, 1911, and transmitted to Committee X through the secretary, is as follows:

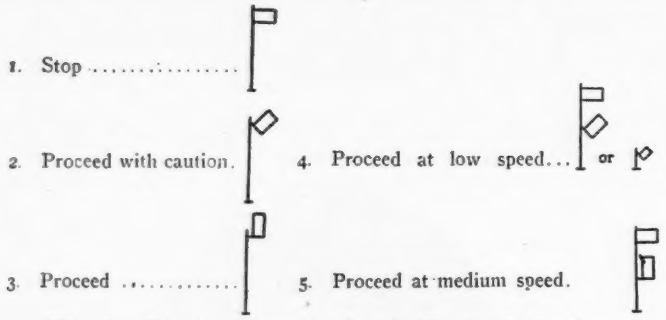


Fig. 1. Simplest Aspects for A. R. A. Indications.

Memorandum on the Essentials of Signaling.

(Incorporated in the report of the Committee on Transportation of the American Railway Association, May, 1911.)

The reports of various committees of the Railway Signal Association and of the American Railway Engineering and Maintenance of Way Association on the subject of signaling have been submitted to this committee, with the request that the essentials of signaling be outlined or defined for the future guidance of their committees.

The subject has been carefully analyzed and considered.

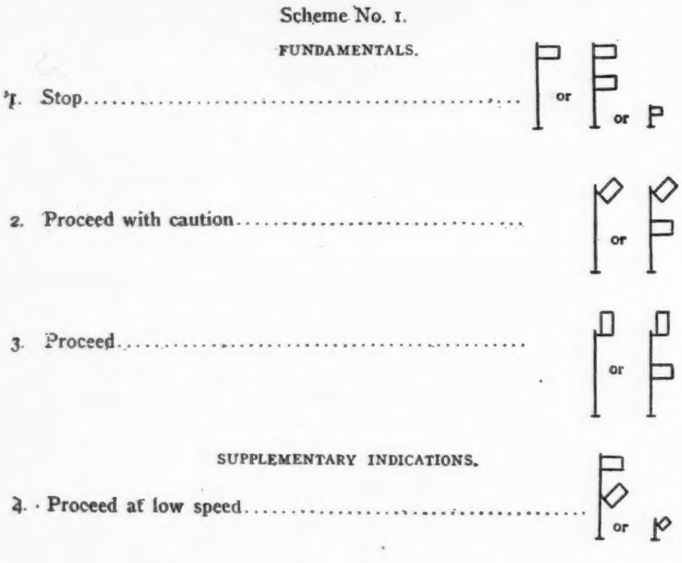


Fig. 2. Aspects Recommended for Roads Desiring to Use Simple Indications With Combinations.

There are three signals that are essential in operation and therefore fundamental, viz.:

(1) Stop.
(2) Proceed with caution.
(3) Proceed.

The fundamental, "Proceed with caution," may be used with the same aspect to govern any cautionary movement, for example, when

(a) Next signal is "stop."
(b) Next signal is "proceed at low speed."
(c) Next signal is "proceed at medium speed."
(d) A train is in the block.
(e) There may be an obstruction ahead.

There are two additional indications which may be used where movements are to be made at a restricted speed, viz.:

(4) Proceed at low speed.
(5) Proceed at medium speed.

Where automatic block system rules are in effect, a special mark of some distinctive character should be applied at the stop signal.

The committee therefore recommends as fundamentals:

(1) Stop,
(2) Proceed with caution,
(3) Proceed,

and as supplementary indications to be used where required:

(4) Proceed at low speed,
(5) Proceed at medium speed.

Stop signals operated under automatic block system rules should be designated by some distinctive mark, to be determined by each road in accordance with local requirements.

Recommendations of Committee X.

The simplest aspects for the three fundamental indications are shown as 1, 2 and 3, Fig. 1.

Having in view, and not desiring to depart from, the established practice of indicating diverging routes and incidentally low and medium speeds, the committee recommends that the medium and low speed indications be given by an additional arm or arms. The simplest method (although incapable of expansion to provide additional aspects or even combinations of the fundamentals and supplementaries) is to use a second arm for both of these indications. The Committee on Transportation rules that the fundamental, "Proceed with caution," may be used to govern any cautionary movement. Therefore, for those roads which desire to operate under this plan and deem the five indications entirely sufficient, two additional aspects are necessary, shown as 4 and 5, Fig. 1.

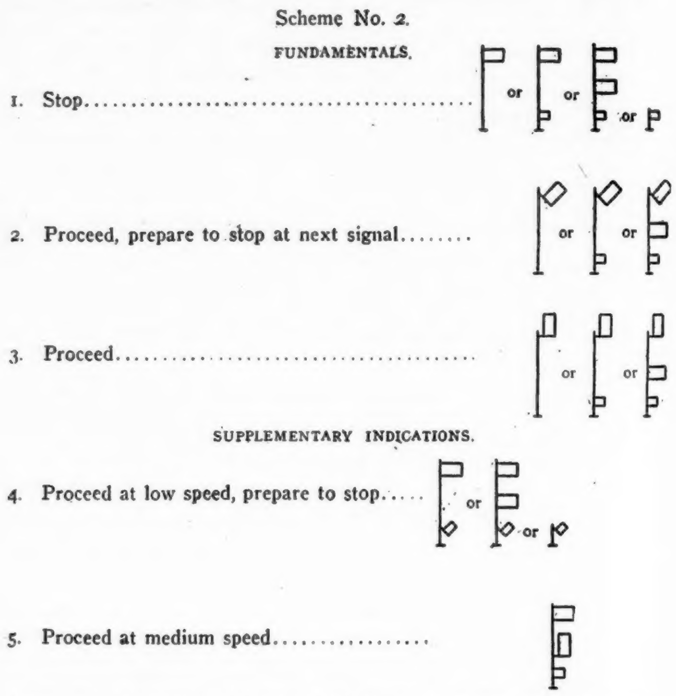


Fig. 3. Aspects for Combinations of Fundamental and Supplementary Indications.

At interlocking plants which are also block stations it may be desirable, even on such roads, to give passenger trains caution signals for diverging movements, but not for entering occupied block sections; this would, with the system outlined above, require a separate signal beyond the interlocked switches. It may frequently also be desirable to display the fundamental, "Proceed with caution," on the medium-speed route, and to logically and consistently apply the fundamental aspects for "Proceed with caution" and "proceed" to those signals indicating medium speed and low speed, the 45-deg. position should be used for caution and the vertical for proceed.

Again, as the Committee on Transportation merely makes optional the combination of various indications under caution and as several roads have found it desirable to differentiate between such indications, the committee recommends for

such roads a low arm as a low-speed arm and a middle arm where the indication of medium speed is desired.

The Committee on Transportation states that "stop signals operated under automatic block system rules should be designated by some distinctive mark to be determined by each road in accordance with local requirements." The instructions to this committee are to design a uniform system, which end is defeated if each road uses a different method of designating the automatic home signal. Therefore, the committee recommends as follows:

Conclusions.

(1) On roads desiring to operate with the three fundamentals and the two additional indications without expansion or combination of these indications, the aspects shown in Fig. 2 may be used.

(2) On those roads desiring combinations of the fundamentals and supplementary indications and different aspects for the various caution indications permissible under the ruling of the Committee on Transportation, the aspects shown in Fig. 3 should be used.

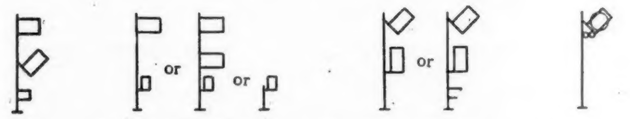


Fig. 4. (a)—Conclusion 3. (b)—Conclusion 4. (c)—Conclusion 5. (d)—Conclusion 6.

(3) When it is desired to indicate "Proceed at medium speed, prepare to stop at next signal," the aspect shown at (a), Fig. 4, should be used.

(4) When it is desired to indicate, "Proceed at low speed," one of the aspects shown at (b), Fig. 4, should be used.

(5) When it is desired to indicate, "Proceed, prepare to pass next signal at medium speed," one of the aspects shown at (c), Fig. 4, should be used.

(6) Where in manual block territory, it is desired to indicate "Proceed with caution, block occupied," the aspect shown at (d), Fig. 4, should be used.

(7) That the arms of automatic signals be pointed and the arms of other signals giving the stop indication have square ends; that, on roads using Scheme No. 1, a number plate be added on the automatic signal and, on roads using Scheme No. 2, a red marker light below and to the left of the active light be provided.

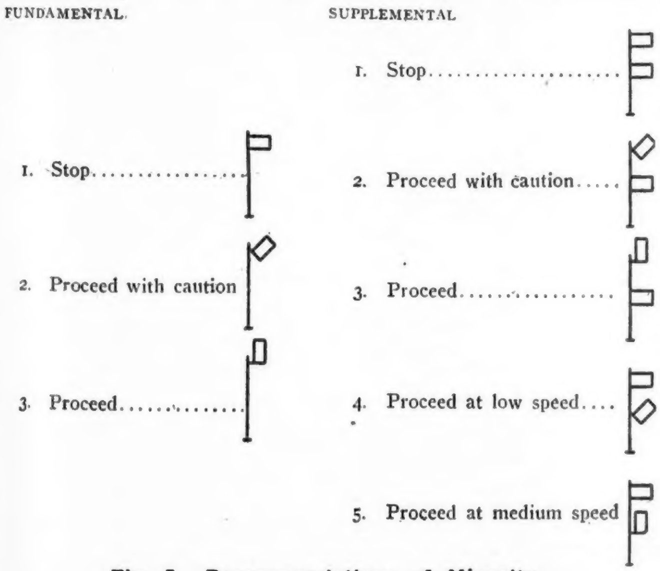


Fig. 5. Recommendations of Minority.

The report is signed by A. H. Rudd (P. R. R.), Chairman; L. R. Clausen (C. M. & St. P.), Vice-Chairman; Azel Ames, C. C. Anthony (P. R. R.), H. Baker (C. N. O. & T. P.), H. S. Balliet (N. Y. C. & H. R.), W. B. Causey (C. G. W.), C. A. Christofferson (N. P.), C. E. Denney (L. S. & M. S.), W. J. Eck (Southern), W. H. Elliott (N. Y. C. & H. R.), G. E. Ellis (K. C. Term.), W. J. Harahan (Erie), M. H. Hovey (Wis Ry. Com.), A. S. Ingalls (L. S. & M. S.), J. C. Mock (D. R. T.), F. P. Patenall (B. & O.), J. A. Peabody (C. & N. W.), Frank Rhea (General Electric Co.), W. B. Scott (U. P.), A. G. Shaver (C. R. I. & P.), T. S. Stevens (A. T. & S. F.), H. H. Temple (B. & O.), Edwin F. Wendt (P. & L. E.), J. C. Young (U. P.).

MINORITY REPORT.

Messrs. Baker, Clausen, Scott, Stevens and Young do not approve the report on Subject No. 1 and believe that the indications provided by the American Railway Association are sufficient for the operation of any railway and are all for which the association should provide aspects.

They, therefore, recommend that the indications specified by the Committee on Transportation of the American Railway Association and the aspects shown in Fig. 5 to represent them, be accepted and approved as recommended practice.

(Stop signals operated under automatic block system rules shall be designated by a number plate.)

The specific objection to the additional indications and aspects provided by the majority are the same as previously presented to the association and are in accordance with the arguments presented before the Transportation Committee of the American Railway Association at Niagara Falls in June, 1910.

They are as follows:

1. It is impracticable to provide a separate signal for each of the conditions on a railway requiring cautious running and to maintain the fine-haired distinctions necessary to their interpretation.

2. It is unnecessary, and, in fact, dangerous, to tell the engineman by fixed signal how he shall control his train at some point in advance.

3. Advance information so given is misleading and unreliable, as it is subject to change without notice, and therefore the engineman cannot safely use it. If he does so use it, it is done at the expense of safety.

4. The conditions of modern railway operation do not require trains to be run at full speed past caution signals, and any time gained by this practice is at the expense of safety.

5. Each signal should indicate "Stop" or "Caution" or "Proceed," and have no relation to signals in advance or in the rear.

6. Each signal should be observed in turn as the train comes to it, and not at some point in advance at the option of the engineman.

7. With signals properly located, it is time a train should be run with caution if it has reached a point so close to preceding trains or stop signals in advance that a caution signal is received.

8. No proceed or caution indication should "imply or assure clear track to a point in advance." Railway signaling devices and our methods of communication have not reached the perfection that will admit of this being done. We cannot know positively if the track is clear, and further, it may not stay clear. We are under a moral obligation not to give such misleading information.

9. The giving of information by signal indications about conditions in advance, whether it be regarding the next signal or the next station, or any other object or condition, is wrong practice, productive of laxity and a fruitful source of danger and accident.

10. It will be difficult, if not impossible, to maintain discipline and proper observance of the great variety of caution indications proposed by the majority, because of the fine distinctions involved.

A number of serious and fatal accidents in the past few years, wherein the engineman failed properly to observe the caution signal, but fully intended to stop at the next signal, testify most conclusively to the correctness of this position.

Discussion on Signals and Interlocking.

In the absence of the chairman, L. R. Clausen (C., M. & St. P.) presented the report.

Mr. Clausen: The committee was assigned four subjects and has a report only on subject 1. We have also submitted a revised table of insulation resistances for rubber-covered wires, which is changed as the result of investigations of the committee of the Railway Signal Association. It was submitted to that association at its annual meeting last October and was approved by letter ballot. The changes are comparatively slight and in order to make the American Railway Engineering Association specifications conform to the Railway Signal Association specifications, the committee desires to have this revised table approved by this association. I make a motion to the effect that the revised table of insulation resistances be adopted by this association.

Mr. Elliott: I second the motion.

Mr. McDonald: I move that the table of insulation resistances be adopted in accordance with paragraph 16 as provided in the general rules.

Mr. Clausen: We accept the amendment.

The President: The motion is that this revised table be adopted for publication in the manual.

Motion carried.

Mr. Clausen: The adoption of the table of insulation resistances carries with it th e approval of the same table

for the specifications of cables, both braided and lead-covered. I would, therefore, as representing the committee, move the adoption of this same table, to be included in the specifications for mineral matter, rubber compound insulated aerial cables, braided cables, and also for rubber compound insulated lead-covered cables.

The motion was carried.

Mr. Clausen: The first instruction to the committee was: "Continue investigation of outline and description of a comprehensive and uniform signal system, suitable for general adoption, conferring with proper committee of the American Railway Association." A report of the Signal Practice Committee of the Railway Signal Association has been submitted to the Railway Signal Association and has been rejected by that association. In view of that fact, the committee presents a report on this subject and I move that report be received as information.

Motion carried.

The President: The chair understands that that motion includes the minority report also.

IRON AND STEEL STRUCTURES.

The committee reports as follows:

Subject No. 1.—Investigation on impact and secondary stresses: Appendex B contains a report from F. E. Turneaure, chairman of the Sub-Committee on Impact, giving an outline of the work done by the committee during the past year.

Subject No. 2.—Influence of theory, experiment and experience on bridge design: It was unanimously decided by the committee that it was unable to report adequately on this subject, and the request is therefore made that the subject be dropped.

C. H. CARTLIDGE,
Chairman Committee on Iron and Steel Structures.

Subject No. 3.—Rules for instruction and guidance of inspectors in mills, shop and field: The committee reports progress. The chairman of the sub-committee received discussion from two of the members of his sub-committee, and will probably be able to submit a paper giving the results of their findings during the next few months.

Subject No. 4.—Design of built-up columns: The tender of the services of this committee to collaborate with the joint committee of the American Society of Civil Engineers was made and very promptly accepted. Sufficient time has not yet elapsed to permit the organization of any actual work on this subject. The program proposed by the A. S. C. E. committee is very elaborate and comprehensive and when carried out will immensely increase our knowledge of the subject. In order that this committee do any practical work on this subject, it will be necessary to have funds. The committee understands, of course, that none of the funds of the association are available for this purpose. It feels warranted, however, in recommending that individual roads be asked to contribute for the purpose of making these tests. This work and that of the Impact Committee are original research work and it is hardly necessary to point out the ultimate value of work done in the manner in which it has been done. It will probably be necessary in the near future to take cognizance of these experiments in our specifications for design, but the committee does not recommend that any change be made at present, nor until further experiments on secondary stresses have been made, and if possible, considerable work on columns. The committee will present later a more definite report of the probable amount of money needed for the first year's work. It is expected that this will be very small and that it can easily be raised.

Subject No. 5.—Specifications for erection of steel bridges: In Appendix A the committee presents for the consideration of the association a set of specifications, revised in accordance with the discussion at the last convention and with the written discussions from members and others received since the convention.

CONCLUSIONS.

The recommendations of the committee are:

(1) That the specifications for bridge erection be adopted and printed in the manual.

(2) That the report of the Impact Committee be received as information.

(3) That no change be made at present in the specifications printed in the manual.

The report is signed by C. H. Cartlidge (C. B. & Q.), chairman; A. J. Himes (N. Y. C. & St. L.), vice-chairman; J. A. Bohland (G. N.), Charles Chandler (C. G. W.), C. L. Crandall (Cornell Univ.), J. E. Crawford (N. & W.), J. E. Greiner (B. & O.), J. M. Johnson (L. B. & I. Co.), C. N. Monsarrat (Quebec Bridge), W. H. Moore (N. Y. N. H. & H.), Albert Reichmann (Am. Bridge Co.), A. F. Robinson (A. T. & S. F.), C. C. Schneider (Consulting Engr.), O. E. Selby (C. C. C. & St. L.), C. E. Smith (M. P.), I. F. Stern (Consulting Engr.), F. E. Turneaure (Univ. of Wisconsin).

APPENDIX A.

Specifications for the Erection of Railway Bridges.

1. Work to Be Done.—The contractor shall erect, rivet and adjust all metal work in place complete, and perform all other work hereinafter specified.

2. Plant.—The contractor shall provide all tools, machinery and appliances necessary for the expeditious handling of the work, including drift pins and fitting up bolts.

3. Falsework.—The method of erection and plans for falsework and erection equipment shall be subject to approval by the engineer, but such approval shall not relieve the contractor from any responsibility. Falsework will be built by (insert "railway company" or "contractor"). Falsework material of every character will be provided by the (insert "Railway Company" or "Contractor").

The temporary structure for use during erection and for maintaining the traffic shall be properly designed and substantially constructed for the loads which will come upon it. All bents shall be thoroughly secured against movement, both transversely and longitudinally. The bents shall be well secured against settling, and piles used wherever firm bottom cannot be obtained. Upon completion of the erection, the temporary structure, if the property of the railway company, shall be removed without unnecessary damage, and neatly piled near the site or loaded on cars, as may be directed. If the property of the contractor, it shall be removed in a manner subject to the approval of the engineer.

Falsework placed by the railway company under an old structure or for carrying traffic, may be used as far as practicable by the contractor during erection, but it shall not be unnecessarily cut or wasted.

4. Conduct of Work.—The work shall be prosecuted with sufficient force, plant and equipment to expedite its completion to the utmost extent and in such a manner as to be at all times subordinate to the use of the tracks by the railway company, and so as not to interfere with the work of other contractors or to close or obstruct any thoroughfare by land or water, except under proper authority.

Reasonable reduction of speed will be allowed upon request of the contractor.

Tracks shall not be cut nor shall trains be subjected to any stoppage except when specifically authorized by the engineer.

The contractor shall protect traffic and his work by flagman furnished by and at the expense of the railway company. The contractor shall provide competent watchmen to guard the work and material against injury.

5. Engine Service.—If under the contract, work train or engine service is furnished the contractor free of charge, such service shall consist only in unloading materials and in transferring the same from a convenient siding to the bridge site. Other engine service shall be paid for by the contractor at the rate of $...... per day per engine, the time to include the time necessary for the engine to come from and return to its terminal. When engine service is desired the contractor shall give the proper railway officials at least 24 hours' advance notice and the railway company will furnish the service as promptly as possible, consistent with railroad operations.

When derrick cars are used on main tracks, their movements shall be in charge of a train crew, and the expense of the crew and any engine service other than as noted above shall be charged to the contractor.

6. Transportation.—When transportation of equipment, materials and men is furnished free over the railway company's line, it shall be subject to such conditions as may be stated in the contract.

7. Masonry.—The railway company will furnish all masonry to correct lines and elevations, and unless otherwise stated in the contract, will make all changes in old masonry without unnecessarily impeding the operations of the contractor and railway company's engineers will establish lines and elevations and assume responsibility therefor, but the contractor shall compare the elevations, distances, etc., shown on plans, with the masonry as actually constructed as far as practicable, before he assembles the steel. In case of discrepancy, he shall immediately notify the engineer.

8. Handling and Storing Materials.—Cars containing materials or plant shall be promptly unloaded upon delivery therefor, and in case of failure to do so the contractor shall be liable for demurrage charges. Material shall be placed on skids above the ground, laid so as not to hold water, and stored and handled in such a manner as not to be injured or to interfere with railroad operations. The expense of repairing or replacing material damaged by rough handling shall be charged to the contractor. The contractor, while unloading and storing material, shall compare each piece with the shipping list and promptly report any shortage or injury discovered.

9. Maintenance of Traffic.—When traffic is to be maintained it will be carried on in such a manner as to interfere as little as practicable with the work of the contractor.

Changes in the supporting structure or tracks required during erection shall be at all times under the direct control and supervision of the railway company.

10. Removal of Old Structure.—Unless otherwise specified, metal work in the old structure shall be dismantled without unnecessary damage and loaded on cars or neatly piled at a site immediately adjacent to the tracks, and at a convenient grade for future handling, as may be directed. When the structure is to be used elsewhere all parts will be match-marked by the railway company; when the old bridge is composed of several spans the parts of each shall be kept separate.

11. Metal Work.—Material shall be handled without damage. Threads of all pins shall be protected by pilot and driving nuts while being driven in place.

Light drifting will be permitted in order to draw the parts together, but drifting for the purpose of matching unfair holes will not be permitted. Unfair holes shall be reamed or drilled.

Nuts on pins and on bolts remaining in the structure shall be effectively locked by checking the threads.

All splices and field connections shall be securely bolted prior to riveting. When the parts are required to carry traffic, important connections, such as attachments of stringers and floor beams, shall have at least 50 per cent of the holes filled with bolts and 25 per cent with drift pins. All tension splices shall be riveted up complete before blocking is removed. When not carrying traffic, at least 33⅓ per cent of the holes shall have bolts.

Rivets in splices of compression members shall not be driven until the members shall have been subjected to full dead load stresses. Rivets shall be driven tight. No recupping or calking will be permitted. The heads shall be full and uniform in size and free from fins, concentric and in full contact with the metal. Heads shall be painted immediately after acceptance.

Rivets shall be uniformly and thoroughly heated and no burnt rivets shall be driven. All defective rivets shall be promptly cut out and redriven. In removing rivets the surrounding metal shall not be injured; if necessary, the rivets shall be drilled out.

12. Misfits.—Correction of minor misfits and a reasonable amount of reaming shall be considered as a legitimate part of the erection.

Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins, and a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the engineer and the work of correction done in the presence of the engineer, who shall check the time expended.

The contractor shall render an itemized bill for such work of correction for the approval of the engineer.

13. Anchor Bolts.—Holes for all anchor bolts, except where bolts are built up with the masonry, shall be drilled by the contractor after the metal is in place and the bolts shall be set in Portland cement grout.

14. Bed Plates.—Bed plates resting on masonry shall be level and have a full even bearing over their entire surface; this shall be attained by either the use of Portland cement grout or mortar, or by tightly ramming in rust cement under the bed plates after blocking them accurately in position.

15. Decks.—The (insert "railway company" or "contractor") will frame and place the permanent timber deck.

16. Painting.—The paint will be furnished by (insert "railway company" or "contractor") and shall be of such color, quality and manufacture as may be specified.

Surfaces inaccessible after erection, such as bottoms of base plates, tops of stringers, etc., shall receive two coats of paint before assembling in place. After erection, the entire structure shall receive two coats of paint, allowing enough time between coats for the first coat to dry before applying the second. No paint shall be applied in wet or freezing weather, nor when the surface of the metal is damp. Painting shall be done in good and workmanlike manner, subject to strict inspection during progress and after completion, and in accordance with special instructions which shall be given by the engineer. All metal shall be throughly cleaned of dirt, rust, loose scale, etc., before the paint is applied.

17. Clearing the Site.—The contractor, after completion of the work of erection, shall remove all old material and debris resulting from his operations and place the premises in a neat condition.

18. Superintendence and Workmen.—During the entire progress of the work the contractor shall have a competent superintendent in personal charge and shall employ only skilled and competent workmen. Instructions given by the engineer to the superintendent shall be carried out the same as if given to the contractor. If any of the contractor's employes by unseemly or boisterous conduct, or by incompetency or dishonesty, show unfitness for employment on the work, they shall, upon instructions from the engineer, be discharged from the work, nor thereafter be employed upon it without the engineer's consent.

19. Inspection.—The work of erection shall at all times be subject to the inspection and acceptance of the engineer.

20. Responsibility.—The contractor shall assume all responsibility for loss or damage to his own work, materials or plant, due to any cause; also, for all loss or damage to the railway company's materials or property, and to other property adjacent to the railroad, due to causes within his reasonable control.

The contractor shall assume all responsibility for injury to the workmen and the public, or to any individual; and in case of accident or suit he shall defend the suit in person and relieve the railway company from all costs and expenses, and pay any judgments that may be recovered thereon.

The contractor shall comply with the laws and ordinances affecting the manner of doing work; shall take out all necessary permits and comply with their requirements, and shall take such precaution as may be necessary to protect life and property.

21. Insurance and Bond.—The contractor shall carry such liability insurance as is necessary to protect himself and the railway company against loss or damage caused by injuries to his men, and shall furnish the railway company a bond in form and of a surety acceptable to the railway company, providing for the faithful performance of the work and all matters pertaining thereto, in such sum as shall be specified in the contract.

22. Engineer.—The term "engineer," as used herein, shall be understood to mean the chief engineer of the railway company, or his accredited representative.

APPENDIX B.

Secondary Stresses.

A brief report of progress is submitted relative to tests of secondary stresses, which were carried out during the past summer by the Sub-Committee on Impact and Secondary Stresses.

Through the assistance of the mechanician's shop at the University of Wisconsin the sub-committee was able to develop and manufacture a special form of extensometer for use in measuring secondary stresses. An important requirement of such an instrument is freedom from friction of all moving parts and, in general, a high degree of sensitiveness, combined with stability and strength of framework, convenience of adjustment and manipulation. An instrument was developed along the line of the extensometers used for impact tests, but to secure sensitiveness the principal bearings were made of knife edges, and instead of using a pencil for securing a continuous record, a ray of light is allowed to pass through a minute perforation in a disc at the end of the long lever, and a path of this ray of light is photographed on a moving slip of sensitized paper.

The apparatus proved satisfactory in practical operation, and the method of obtaining the record was found to be very good indeed. The sensitized paper was developed in the field

so that results could quickly be obtained. Four of these extensometers were made by the University of Wisconsin and were used by the committee on its tests.

About three weeks were spent in the field and tests were made on the following bridges: On the Chicago, Milwaukee & St. Paul Railway, a 160-ft. riveted span and a 176-ft. pin-connected span at Bryon, Ill., a 104-ft. pony truss span at Rockton, Ill., in which eye-bars were used for the diagonal members, and a span of the same length at Brodhead, Wis., in which all members were riveted. On the Chicago & North-Western Railway, a 182-ft. riveted truss, a 75-ft. deck-plate girder, and a through riveted lattice truss, all on the new Belt Line at Milwaukee. In all of these tests the railway company furnished a special train, and such other facilities in the way of mechanics as were needed.

The field work was carried out by C. L. Crandall and F. E. Turneaure, members of the sub-committee, assisted by W. L. Conwell and W. A. Axtell, of Cornell University, and W. S. Kinne, O. L. Kowalke and J. B. Kommers, of the University of Wisconsin.

Discussion on Iron and Steel Structures.

A. S. Baldwin (I. C.): I would ask the object of the third clause of paragraph 3 of the Specifications for the Erection of Railway Bridges, which provides that "falsework placed by the railway company under an old structure or for carrying traffic, may be used as far as practicable by the contractor during erection, but it shall not be unnecessarily cut or wasted." That, it seems to me, is a special case and does not apply here. You cannot make a rule of that kind to apply to all cases.

Mr. Porter: It is not an uncommon thing to put bents under a truss that has become light. In a case where I had to do that, I took up the question with a bridge company as to a plan of falsework which had been used in the erection of a new structure, so they put the falsework under our old bridge and there used it when they came to erect a new bridge. In another case, where the old bridge was wrecked by a washout and an engine going onto it, we had to build a trestle across the river in order to keep the traffic open, so we built our trestle over the ditch and it was used for falsework by the contractor in erecting a truss. This is a specification for erection, and it covers cases that do happen in ordinary experience, and I see no objection to leaving it in here.

Mr. Baldwin: There are no two cases alike, in all probability, and consequently it cannot be covered by a general rule. I move that this clause be modified as follows:

"If falsework has been placed by the railway company under an old structure, or for carrying traffic, the use of it by the contractor must be subject to a special arrangement to be made by the engineer of the railway company."

O. E. Selby (C., C., C. & St. L.): I think that the clause as it stands does not represent a special case, but a very usual case. It very frequently happens that falsework has been placed for the purpose of strengthening a weak bridge to enable the bridge to carry the traffic, and it would be unwise to throw it away and not take advantage of it for erection purposes. I do not see how it could lead to complications with the contractor, because it represents an existing condition at the time the contract is let and bids are asked for. If the falsework is there it is there when the bidder examines the job, and be is expected to take note of all the existing conditions.

J. M. Meade (A., T. & S. F.): The Santa Fe has done a great deal of work, almost exactly as outlined in this report, and I believe we should leave that paragraph as it is written.

Mr. Cartlidge: In making these specifications we desired to adapt them as widely as possible to any conditions which are to be met with. It seems to the committee that any clause such as this, which does not meet with the approval of the engineer or the railway company letting the contract, can very readily be eliminated in the draft of the contract made at the time the work is let. These specifications are not intended to be used verbatim, but as a model or guide for drawing up the specifications.

Mr. Baldwin: I think the members have misunderstood the object that I had in view in making this motion. It is not that the falsework should not be used, for it is, of course, in the line of economy that anything existing on the railway should be used, but I wanted to have the clause so worded that the railway company would be sure to get proper credit for it. Take a case in which a railway company is about to let a contract for the erection of all its bridges for a year. The contractor in figuring on these bridges, would figure on the falsework for every one of the bridges; then, at any point where he found falsework, there would be that much net gain to him to which he was not entitled, whereas, if the provision is made in the way I have proposed where the contractor comes to a bridge for which the falsework has been provided, it becomes necessary for him to make a special arrangement for that bridge with the railway company and the railway company gets credit for the material put in there.

Mr. Porter: If this clause is left in the specification, then it does not have to be handled as a special matter, and if a railway is letting a contract for all of its bridges for a year, and takes competing bids, if this clause is in the specification, the chances are that some of these contractors, at least, will take this into consideration, in making their bids, and the railway company would get a lower bid than if this clause is left out. If the clause is left out of the general specification the engineer may omit to take it into consideration when he calls for bids, so I think it is the proper place for it and it should remain.

F. J. Bachelder (B. & O.): This clause seems to be covered in the forepart of the section. It says: "The method of erection and plans for falsework and erection equipment shall be subject to approval by the engineer, but such approval shall not relieve the contractor from any responsibility. Falsework will be built by .... Falsework material of every character will be provided by the ...."

That, it seems to me, covers these particular cases, and we could eliminate the latter clause.

Mr. Baldwin's motion was put to vote and lost.

E. A. Frink (S. A. L.: The second paragraph of section 4 reads: "Reasonable reduction of speed will be allowed upon request of the contractor." That means that upon the request of the contractor the railway company will issue a "slow order" limiting the speed over the structure to a certain degree. I think there should be a clause added specifying that the railway company will not be responsible for any injury to the property or structure of the contractor, due to failure on the part of the railway company to carry out the "slow order." In one case on the Seaboard we had a "slow order" over a structure and the contractor was engaged in building a cofferdam which he tied up to the structure. Some of the trains over the structure exceeded the speed limit and the contractor thereupon set up a claim, which he substantiated in court, that the Seaboard was responsible for the damage to his work because it did not maintain the slow order. I move to amend that paragraph by adding: "The railway will not thereby in any way incur any responsibility for damage to the work or materials of the contractor for failure to maintain such reduction in speed."

Thomas Earle (Penna. Steel Co.): It seems to me that the addition of this clause would nullify the balance of the paragraph. What is the advantage to a contractor of a slow order if he knows beforehand that he is not to expect that slow order to be fulfilled; and, in addition, if there is a slow order of thirty miles and a train goes through at sixty miles, and his entire plant is destroyed, and he has to pay for it, it will add a burden on the contractor, but in the end the railway company will pay for all such clauses, because the contractor must eventually be reimbursed for all such expenses by his customers, who, in this particular case, are the railways.

J. L. Campbell (E. P. S. W.): I do not believe that you can release a railway company from proper responsibility by the insertion of such a clause and I believe it would impair the force and effectiveness and dignity of the work of this association to put such a clause as that in the specification.

Mr. Bachelder: This clause does not specify the speed restriction which is to be placed on the structure. It simply provides for a reasonable reduction of speed. I think the clause should stand as written.

Albert Reichmann (Am. Br. Co.): I think the words "reasonable reduction of speed will be allowed" are sufficient. In my opinion, the word "reasonable" takes care of that.

Mr. Sullivan: Would it not be better to say "a reasonable reduction of speed will be allowed on the recommendation of the company's engineer"? He is responsible for the work, and if the contractor is going to fail by running trains at sixty miles an hour he is not going to allow it.

Mr. Stein: I believe the point that has been raised is practically covered by a succeeding paragraph which reads: "The contractor shall protect traffic and his work by flagmen furnished by and at the expense of the railway company." It is the business of the contractor to see that these flagmen carry out their instructions and hold the speed of these trains down to the limit placed on them by the engineer in charge and the operating department, so that I do not think it is necessary to introduce any additional clause in these specifications.

Mr. Porter: I offer an amendment to read as follows: "Reasonable reduction of speed, upon request of contractor, can be provided for in the contract."

The President: That is so different from the amendment already proposed that it cannot be received.

Mr. Porter: The point I want to make is that in some contracts you do not want any reduction of speed whatever, and you require the contractor to take out the old bridge and put in a new one between trains, without either stopping or delaying traffic. This being a general specification, the contract let under this specification entitles the contractor to a reasonable reduction of speed if he should so request.

The amendment proposed by Mr. Fink was put to vote and lost.

E. G. Brown (Carnegie Steel Co.): Is it not a fact that some railway companies do not admit of any reduction whatever in the speed?

Mr. Cartlidge: The specification attempts to cover all cases and such clauses as apply to particular cases, which are not required at the time of letting the contract, may be very readily eliminated.

Mr. Baldwin: I think it is good practice to require the contractor to pay part of the cost of the work train service. Where the full expense of the work train service is paid for by the railway company the contractors call for work trains where they could be avoided and are negligent in letting them go, and I have made it a practice to give a price for the service of the work train per day that will about divide the cost between the railway company and the contractor.

Mr. Cartlidge: The committee spent more time over that clause than any other in the specification. It is a very difficult one to cover. The practice differs widely on different roads. If the specification does not set forth the conditions under which the contractor must make his bid he is likely to add something for good measure to cover the question at issue. If he has an indefinite amount of train service to pay for he is going to put in his estimate a flat price to cover all that he will have to pay for, certainly, and it is necessary either to put all of it on the railway company or all of it on the contractor in the general specification. It would be very easy to amend these specifications for particular cases, but it would be very difficult to make a wording which would provide for all cases in practice.

E. F. Wendt (P. & L. E.): For some years our company followed the practice of furnishing free transportation for materials and other work train service. There is so much difficulty in connection with this practice that we found it convenient to abolish that practice, and at the present time we compel all contractors to bid on just one condition, namely, the bid shall include all transportation of both men and materials and all cost of work train service. Where this practice can be followed the engineer has a great deal less trouble in connection with his field work and his accounts, and I believe that is the practice to which we are rapidly tending.

Mr. Earle: The fourth paragraph of Sec. 11 reads: "All splices and field connections shall be securely bolted prior to riveting. When the parts are required to carry traffic, important connections, such as attachments of stringers and floor beams, shall have at least 50 per cent of the holes filled with bolts and 25 per cent with drift pins." I think 50 per cent with drift pins and 25 per cent with bolts will give better results. Drift pins absolutely fill the hole, and if you have both drift pins and bolts, in the same splice, the drift pins will carry all the stresses, as they are the only ones actually in contact.

Mr. Cartlidge: I think it is conceded that not all rivets fill all the holes and that a good many of our structures are being carried on friction.

Mr. Cartlidge: The style of drift pins with which I am familiar are tapered and the largest diameter of the pin is the diameter of the 15/16-in. rivet hole. As that diameter occurs in only one place in the length of the drift pin it is a little difficult to see how that action of a tapered drift pin in a cylindrical hole can be any better than a bolt.

Mr. Selby: These specifications are intended to represent recommended practice, and to a great extent common practice, and I would ask Mr. Earle if he knows of it being common practice, to use ⅔ drift pins and one-third bolts?

Mr. Earle: That is practically the way we do work where we carry heavy traffic, although it is seldom we have to carry heavy traffic on steel work of that kind. It has the approval of our engineer.

Mr. Cartlidge: It is the opinion of the committee that common practice and better practice is for the bolts to be in the larger proportion and the drift pins in the minority.

After talking over Sections 20 and 21 with the committee, I move their elimination from the specification.

Motion carried.

A motion to approve these specifications for publication in the Manual was carried.

A motion to receive the report of the Sub-Committee on Impact and Secondary Stresses as information was carried.

WOODEN BRIDGES AND TRESTLES.

The work assigned was as follows:

(1) Report on the formulas for use in determining the strength of sheet piling.

(2) Report on equipment required for pile driving.

(3) Collect information on special methods of driving sheet piles in cofferdams where conditions do not permit the use of ordinary equipment.

(4) Collect information on actual experience on the bearing power of piles and on the practical results of the use of formulas.

(5) Report on the use of guard rails for wooden bridges and trestles.

(6) Report on fire protection of wooden bridges and trestles.

Subjects Nos. 1, 4, 5 and 6 were selected for consideration this year. The committee reports progress as follows:

(1) The committee did not think this subject could be reported on this year, as an experimental investigation, which it was hoped Cornell university would make, could not be completed in time for report if undertaken. It was thought that the result of these experiments would be of much service in making up its final report to the association. The committee has since been advised that Cornell could not undertake these experiments, but the committee hopes that some other institution may find it desirable that they be carried out.

The procedure suggested for these experiments was that a strong concrete open top box be made, across which at its middle a vertical plate diaphragm of tempered spring steel could be set; this diaphragm being held in place against horizontal motion at its top and bottom. On both sides of this diaphragm the box would be simultaneously filled with the material to be tested, as sand; thus, when the box is full, representing sheet piling driven in sand. The sand was then to be removed from one side of the diaphragm, as would occur when a trench is excavated protected by sheet piling. After the diaphragm had assumed the curve due to the pressure of the sand its curved shape was to be accurately determined and a closely fitting template made to record its curvature.

In order to determine the amount and distribution of the sand pressure, the diaphragm would then be removed from the box and placed horizontally, supported at its ends at the same points it was supported by when vertical in the box. A number of metal strips should be provided, each long enough to reach across the diaphragm, but of varying thickness to make up any required weight, and of equal width. These would be piled at equal intervals on the diaphragm until the curve of flexure is again exactly reached by it which was given it by the sand and recorded by the template; bearing in mind that the tops of the successive piles of metal strips must be on a curve of some uniformity, which may be called the curve of load, without such irregular outline as that of a battlement, and carried over the supports on the line indicated by the curve approaching them. The total pressure, and the center of pressure, would thus be determined, it is thought, with considerable accuracy.

As a check, the flexure curve of the diaphragm already found could be plotted to a convenient scale, and successive differentials taken thereof up to and including the fourth. As the equation of this flexure curve is unknown, the differentiation would be done graphically, remembering that the first differentiation gives the curve of tangents to the flexure curve; the second the curve of moments; the third the curve of shear, and the fourth the curve of load, which should agree with the curve of load determined by the first method—that of weights superimposed on the horizontal plate.

Other materials than sand need testing, such as a heavy semi-fluid mud, and ballast. In each case the angle of repose would be noted of the unretained material, and its weight per cubic foot.

In order to obtain definite conclusions the concrete box and steel diaphragm should be of rather large size; and to prevent the friction of the retained material on the sides of the box from affecting the result materially, narrower steel plates could be placed on each side of the main diaphragm, observations being taken on the main plate only.

The investigation could be extended to determine the pressure on abutments, which are generally filled against gradually on one side only, though this is not part of the work of this committee. It seems probable that under such mode

of filling, the total pressure would be greater, and its center lower, than in the case of sheet piling.

(4) Pile Formulas—F. E. Bissell, F. H. Bainbridge, R. D. Coombs and W. F. Steffens, sub-committee:

A large number of requests for information were sent out, but the chief matter to be noted from the replies received was the very small number of roads keeping record of their pile driving in form for use in this investigation.

It seems to the committee that while a pile driving formula should be based on theoretical considerations, there are so many modifying conditions to be allowed for that the result is a formula more or less empirical in its final make-up. These modifying conditions can best be noted from actual experience in pile driving; and members are urged to keep record of the behavior of piles during driving and after loading. This record is especially valuable in the case of test piles loaded to failure.

(5) Guard Rails—H. Ibsen, H. S. Jacoby, I. L. Simmons and H. Rettinghouse, sub-committee:

Replies were received from members and others representing a mileage of 119,314. These replies were tabulated and considered, but recommendations were not reached for presentation to the association. It seems that there are two types of guard rail in use. In one type the two rails are brought together at their ends at the middle of the track; in the other, two similar rails are not brought together at their ends, but remain parallel to the stock rail, and a third rail, also straight, is put in the middle of the track; all three rails in the latter case being deflected at their ends below base of rail.

(6) Fire Protection—I. L. Simmons, F. H. Bainbridge, F. E. Bissell, H. Ibsen and J. A. Lahmer, sub-committee.

Replies to a circular letter of inquiry were received from members and others representing 110,214 miles of railway. Of this mileage 62 per cent, when using fire protection, adopted either full ballast decks, floors protected by a thin covering of ballast or other like material, or by sheet metal.

The report is signed by C. C. Wentworth (N. & W.), chairman; W. F. Steffens (B. & A.), vice-chairman; F. H. Bainbridge (C. & N. W.), F. E. Bissell (A. C. & Y.), W. S. Bouton (B. & O.), R. D. Coombs (Consulting Eng'r), E. A. Hadley (M. P.), Hans Ibsen (M. C.), Henry S. Jacoby (Cornell Univ.), J. A. Lahmer (K. C. S.), H. Rettinghouse (C. & N. W.), I. L. Simmons (C. R. I. & P.).

Discussion on Wooden Bridges and Trestles.

Mr. Wentworth: The present committee does not wish to make any recommendation at this meeting. I move that this report be accepted as a progress report and information.

Motion seconded and carried without discussion.

BALLAST.

THE PROPER DEPTH OF BALLAST TO INSURE UNIFORM DISTRIBUTION OF THE LOADS ON THE ROADBED.

The report of the committee on the proper depth of ballast submitted during the year 1910 was in the form of a progress report, accompanied by a table showing the approved depth of ballast on various railways, but on account of the lack of sufficient information on which to base definite recommendations, no action was taken on this subject by the association.

Depth of ballast should be defined as the distance from the bottom of the tie to the top of the subgrade.

The committee feels that very valuable information was given to the association in the report of the Pennsylvania Railroad committee on the necessary depth of stone ballast, published in Bulletin 136, through the kindness of W. C. Cushing, president of the association, and L. R. Zollinger, chairman of the committee appointed by the general manager of the Pennsylvania Railroad. The details of the test were published in the *Railway Age Gazette* of July 21. The conclusions concerning the proper depth of ballast which will insure uniform pressure on the subgrade are as follows:

With an axle load of approximately 75,000 lbs. passing over test ties on the test ballast at five miles per hour the subgrade practically reached a permanent settlement. Where the ballast was materially less than 24 in. the settlement of the subgrade (loam) under the ballast was not uniform, but showed a greater settlement under the ties than between the ties. When stone ballast was placed 24 in. deep under the ties the settlement of the subgrade (loam) under the ballast was practically uniform, and therefore the pressure must have been approximately uniform. A combination of stone and cinder ballast 24 in. deep under the ties (lower layer of cinders 18 in. to 14 in. deep, upper layer of stone 6 in. to 10 in. deep) gave nearly as good results, although the deformation of the subgrade was greater than with 24 in. of stone ballast.

The result of this series of tests, which indicated that approximately 24 in. of stone ballast is required to produce a uniform pressure on the subgrade, with the ties spaced 24 in. to 25.5 in., center to center, agrees very closely with the formula given by Thos. H. Johnson in the proceedings for 1906, which was derived from the experiments of Director Schubert, namely, that with ties spaced 23 in. apart, center to center, stone ballast should be 22 2-3 in. deep to produce uniform pressure on the subgrade.

Conclusion.

From the data available the committee finds that with 7 in. by 9 in. by 8½ ft. ties spaced approximately 24 in. to 25.5 in., center to center, a depth of 24 in. of stone ballast is necessary to produce uniform pressure on the subgrade, and a combination of a lower layer of 18 in. to 14 in. of cinder ballast and an upper layer of 6 in. to 10 in. of stone ballast a total depth of approximately 24 in. with the same spacing of the ties will produce nearly the same results.

PHYSICAL TESTS OF STONE FOR BALLAST.

The physical tests of stone for ballast adopted by the association and described in 1910 were the first tests of this character adopted by the association, and the question of revising them, if necessary, or adding other tests to those adopted, was again referred to the Ballast Committee for further investigation and consideration. The committee ascertained that the railways as a rule have no uniform practice in making physical tests of stone for ballast. Some of the roads select their stone for ballast by simply observing the character of the stone, and then ascertaining its durability and fitness for ballast by the actual results obtained in track. Some roads require a compression test in their specifications, but only one railway was found to have used the physical tests made by the United States Government previous to their adoption by the association as above referred to.

H. E. HALE,
Chairman Committee on Ballast.

The committee does not recommend any changes in the physical tests already adopted, but feels that the tests would be more complete if the compression test were added. With this in view the question was taken up with the Department of Agriculture of the United States Government and they have agreed to add the compression test to those adopted by the association.

The description of the compression test, which the Government will make, is as follows: A cylinder 2 in. in diameter and more than twa in. long is drilled from the specimen of stone to be tested by means of a diamond core drill, and sawed to a length of 2 in. by a band saw fed with emery. The specimen is finally faced off on each end by means of a power-driven grinding lap, on which water and emery are continuously fed.

The cylinder then has both ends embedded in plaster of paris, the bed being mac- as thin as possible and both ends being made parallel. It is next mounted on an Olsen test machine on a special bearing block between blotting papers,

three thicknesses being placed at each end, between the cylinder and the steel-bearing faces of the machine. The load is applied at a speed of 0.152 in. per minute, the machine being kept balanced during the application of the load.

The committee believes that with the physical tests of stone for ballast, which the association adopted, and the compression test above described, sufficient information will be given by which to compare the character of stone from the various quarries from which it is proposed to obtain ballast.

Name of Railway	Location of Gravel Pit	PERCENTAGES					Remarks
		Dust and Clay	Sand	Gravel	Rock	Voids	
A. T. & S. F.	Chillicothe, Illinois	2.2	51.0	38.0	No Data	No Data	Good gravel ballast.
C. B. & Q.	Atchison, Kansas	10.0	12.7	77.3	0.0	No Data	Per cent. by weight. Main track.
C. B. & Q.	O'Neill, Neb	8.5	57.5	34.0	0.0	No Data	Per cent. by weight Branch line.
C. B. & Q.	Ballantine, Montana	7.0	4.9	52.5	35.6	No Data	Per cent. by weight. Main line.
C. B. & Q.	Peetz, Colorado	4.8	51.5	42.5	1.2	No Data	Per cent. by weight. Main line.
C. R. I. & P.	Chillicothe, Illinois	0.0	60.0	40.0	0.0	No Data	Per centage arrived at by volume.
C. R. I. & P.	Grattinger, Iowa	16.4	41.4	53.7	No Data	No Data	Percentage arrived at by volume.
C. R. I. & P.	Benton, Arkansas	23.3	20.8	79.2	No Data	No Data	
C. R. I. & P.	On St. Louis Division	5.8	22.0	80.0	No Data	No Data	
C. R. I. & P.	Nydia, Ark	16.3	11.8	90.9	No Data	No Data	
G. R. & I.	Big Rapids, Michigan	6.0	32.0	78.0	No Data	No Data	Showa as good quality of ballast.
G. R. & I.	Sand Lake, Michigan	18.0	44.0	63.0	No Data	No Data	Shown as fair quality of ballast.
G. R. & I.	Leroy. Michigan	5.0	30.0	80.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	Belmont Pit	0.5	15.0	91.0	No Data	No Data	Shown as good quality of ballast.
G. R. & I.	M., G R. & I.	0.0	40.0	75.0	No Data	No Data	Shown as fair quality of ballast.
G. R. & I.	Paris Pit	15.0	40.0	70.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	Grapo	11.0	36.0	72.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	Reed City	5.0	40.0	72.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	Tustin	8.0	42.0	72.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	K. S. Tower Pit, Oden	13.0	60.0	48.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	K. S. Tower Pit, T. C. Sect. 2	18.0	49.0	55.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	K. S. Tower Pit, T. C. Sect. 3	15.0	56.0	50.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	K. S. Tower Pit, T. C. Sect. 4	16.0	55.0	50.0	No Data	No Data	Shown as poor quality of ballast.
G. R. & I.	Suttons Bay Pit	15.0	36.0	67.0	No Data	No Data	Shown as poor quality of ballast.
I. C.	Forreston, Illinois	4.8	17.2	72.0	6.0	20.0	
I. C.	Riverton, Indiana	7.9	23.5	68.6	0.0	13.4	
I. C.	Gravel Switch, Kentucky	7.0	6.2	85.0	1.8	18.8	
I. C.	Memphis, Tennessee	3.3	17.8	77.7	1.2	17.3	
Mo. Pac.	Fowler, Colorado	2.0	65.0	23.0	0.0	No Data	Fair results.
Mo. Pac.	Ft. Gibson, Oklahoma	5.0	4.0	94.0	0.006	No Data	Clay included in percentage of sand.
Mo. Pac.	Bethel, Arkansas	4.0	34.0	76.0	0.0	No Data	
N. Y. C. & H. R.	Beaver River	18.0	55.0	27.0	No Data	No Data	Sample No. 16.
N. Y. C. & H. R.	Yosts	5.0	20.0	75.0	No Data	No Data	Sample No. 17, first quality.
N. Y. C. & H. R.	Glenfield	18.0	57.0	25.0	No Data	No Data	Sample No. 19, coarse sand, very good but dusty.
N. Y. C. & H. R.	Todds	10.0	35.0	55.0	No Data	No Data	Sample No. 18.
N. Y. C. & H. R.	Fishers	8.0	27.0	65.0	No Data	No Data	Sample No. 21.

Percentage of Sand, Clay, Etc., in Gravel Ballast.

As a matter of information the committee has, during the past year, requested a number of railways to send samples of their stone ballast to the Government for test, and through the assistance and courtesy of these railways is enabled to present a tabulated statement of the results of these tests. While this statement is not as complete as was desired, we feel it will be of considerable value in studying this question.

The advantage of using approved physical tests of stone for ballast to determine the character of the stone and its fitness far ballast is that without some method of determining this by physical tests, railways will undoubtedly be put to considerable expense by opening quarries and applying stone ballast, which in some cases will have to be replaced with better ballast from other quarries.

Conclusions.

The committee recommends that in addition to the physical tests of stone for ballast, which have been adopted by the association, that the "compression test," above described, be adopted and included in the manual.

The committee also recommends that the following reference be made in the manual to the description of the tests and the action necessary to have tests made:

"For the description of the physical tests of stone for ballast as recommended by the association and full instructions as to how the samples should be obtained and shipped to the Government, see Proceedings of the American Railway Engineering and Maintenance of Way Association, Vol. II, Part 2, pp. 910-914, and report of Ballast Committee of 1912. If blueprints of the machine used in making the tests are desired, they can be obtained from the Department of Agriculture, United States Government, Washington, D. C."

COMPLETE REVIEW OF GRAVEL BALLAST AND RECOMMENDED METHODS FOR GRADING THE DIFFERENT QUALITIES.

In the proceedings for 1910 a classification of gravel ballast was adopted by the association, which depended on the amount of sand and dust found in the gravel, the size of the sand, and the size of the gravel, being determined in accordance with the definitions of sand and gravel given in the manual. This subject was again referred to the Ballast Committee for a complete review.

During the year the committee requested a number of railways to test their gravel ballast and determine the percentage of sand, gravel, dust, etc., in the ballast, following the definitions of sand and gravel given in the manual. A statement is presented showing the percentages as found in ballast now in use, and a brief of the reports obtained from the railways in regard to the use of these deposits of gravel for ballast is as follows:

The Santa Fe reports that it is using the Chillicothe gravel almost entirely and finds it to be very satisfactory, giving good results on the roadbed, as it comes from the pit, using 12 in. under the ties.

The Chicago, Burlington & Quincy reports show gravel being taken from four different places, and put under the tracks as it is loaded from the pits, which makes excellent track, binds well and is easily worked.

The Chicago, Rock Island & Pacific reports gravel taken from five different places, the best being from Benton, Ark., on their southern lines, but not equal to the glacial gravel of Iowa and Illinois. The gravel was used on the track as it came from the pits, and not washed.

Twelve tests of pits on the Grand Rapids & Indiana are shown in the tabulated statement. The ballast is not washed, but is put in the track as it comes from the pit.

In the case of the Illinois Central the tabulated statement shows tests from four different places, and the ballast from each is used in the track as it comes from the pits, except in the case of the Memphis gravel, which is taken from the bed of the Mississippi River and washed.

The Missouri Pacific reports tests from three different places, and like the other roads the ballast was used on the track as it came from the pits.

It will be seen from the reports of the six different roads that no expense was incurred in washing or screening the gravel, which was used upon the tracks as it came from the pits, except in the case of the Illinois Central, for gravel secured at Memphis.

A report from the chief engineer of the Intercolonial of Canada states that he is of the impression that if they screened their gravel they would not get as good results as if they took the sand with a coarser material combined.

A report from the engineering department of the Canadian Pacific states that they are ballasting with gravel taken direct from the pit, without any cost of treatment.

The committee further endeavored to determine the maxi-

mum amount of clay which would be permissible in good cementing ballast, and by reference to the data we have on this subject we find that most of the tests that have been made of gravel ballast give very meager information as to the amount of clay in cementing ballast. From the best information at hand the committee is of the opinion that where the clay amounts to over 10 per cent, it would be quite objectionable.

The committee wishes to give a high indorsement of the report on "Gravel as Ballast," by C. Bräuning, which W. M. Dawley had translated from "Zeitschrift für Bauwesen," Vol. LIV, Berlin, 1904.

Conclusions.

The committee recommends further investigation of the amount of sand, dust and clay, permissible in good gravel ballast, since reports obtained this year from various railways, and attached hereto in a tabulated statement, indicate wide variations in the amount of these materials found in gravel ballast in actual use, yet reported as giving good results.

The report is signed by H. E. Hale, (M. P.) chairman; J. M. Meade, (A. T. & S. F.) vice-chairman; W. J. Bergen (N. Y. C. & St. L.), A. F. Blaess (I. C.), T. C. Burpee (Intercolonial), F. T. Darrow (C. B. & Q.), J. M. Egan (I. C.), T. W. Fatherson (C. R. I. & P.), H. L. Gordon (B. & O.), G. H. Harris (M. C.), C. C. Hill (M. C.), S. A. Jordan (B. & O.), A. S. More (C. C. C. & St. L.), J. V. Neubert (N. Y. C. & H. R.), S. B. Rice (R. F. & P.), E. V. Smith (B. & O.), F. J. Stimson (G. R. & I.), S. N. Williams (Cornell College).

Discussion on Ballast.

Mr. Hale: The committee would like to have the association approve the definition of "depth of ballast," first, and then the conclusions of the three sub-committees.

A motion to adopt the definition of "depth of ballast" was carried.

A motion to adopt the conclusion as to the proper depth of ballast to produce uniform pressure on the sub-grade was carried.

Mr. Morse: Regarding the Pennsylvania experiment on the value of cinders to help make up the 24-in. depth of ballast, I had an experience ten or fifteen years ago on a piece of line about twenty miles long with 1½ or 2 ft. of cinders for ballast. We replaced that with slag, and for at least four years we were having to work on that slag ballast continuously on account of the settlement of the cinders under it. While it showed up well as an experiment, it did not show up well in practice.

C. E. Lindsay (N. Y. C. & H. R.): I am sure the committee, in using the words "cinder ballast," does not preclude gravel ballast or better ballast.

The President: The committee would be glad to add gravel if that would tend to make it more acceptable to the association.

C. S. Churchill (N. & W.): While the test of stone for ballast may be all right, it is one that the railways cannot ordinarily make, because they do not have at hand a diamond drill of this size, and do not have the means of cutting this core required in the test. We have been conducting, for several years, a test by means of a cube cut with a chisel and the relative strength of every stone can be determined in that way, just as well as it can by means of the cores. Therefore, while I do not wish to suggest that this test be not agreed to, I think there should be some latitude given for another form of compression test, such as can be readily made by any railway without going to the Government.

Mr. Hale: The physical tests of stone which are recommended in the manual are covered by a description in the proceedings of the association and are made by the government at Washington. They were originally started for testing material for wagon roads, and they were the most complete set of physical tests for stone that the committee could find, and the fact that the Government makes them at Washington for any railway or corporation or individual free of charge on sending the sample made it, in the opinion of the committee, very advantageous to accept these tests as described by the Government and use them altogether. It makes a very uniform test and is readily comparable with other stone known to the railways.

A motion to adopt the first paragraph of the sub-committee's conclusions was carried.

A motion to incorporate in the manual the recommended reference to these tests was carried.

TIES.

SIZE OF CROSS-TIES REQUIRED FOR THE STRESSES TO WHICH THEY ARE SUBJECTED.

The stresses to which ties are subjected cannot be considered as having no interrelation to the other parts of a roadway. On the contrary, the size of the rail, the load above and the bearing beneath the tie, the subsoil, the character of the material between ties, the presence or absence of tie-plates, the use of screw or common spikes, and many other conditions, actual and theoretical, must be considered. It was thought best to obtain from various members opinions along certain lines and for that purpose a set of questions was prepared by the sub-chairman and sent out by the secretary to all members.

(1) What percentage of a rail length should have a bearing on the ties? Does the per cent mean per cent of linear distance or bearing area?

(2) Has this percentage any relation to (a) Kind of timber used for ties? (b) Kind of ballast? (c) Character of sub-grade? (d) Tangent vs. curve? (e) Minimum distance between face of ties?

L. A. DOWNS,
Chairman Committee on Ties.

(3) If the percentage is capable of mathematical deduction, please give the method, etc.

(4) Is crushing hastened by natural checking of ties?

(5) Which class of wood checks most?

(6) Does preservative treatment tend to increase the tendency to check?

(7) Does preservative treatment affect the natural crushing unit stresses?

(8) (a) With the increased tie consumption and the decreased available tie supply, can the demand for larger sectional area of ties be met? (b) If a larger sectional area of the tie is not available, what would you recommend as next best thing to do—use steel or composite or what not?

(9) Has the application of screw or square spikes any effect on crushing?

(10) Relation of kinds of ballast to tie crushing?

(11) Relation of character of sub-grade to tie crushing?

(12) Relation of axle load to tie crushing?

(13) Relation of frequency of maximum axle load as applied to a tie to tie crushing?

(14) Relation of maximum axle load to weight of rail and consequent tie crushing?

(15) Relation of impact at joints to tie crushing?

(16) Relation of size of tie-plates to crushing of ties?

Forty replies, representing about four per cent of the membership, or 32 per cent of the mileage represented in the association, were received and tabulated.

The table prepared by the tie committee in 1905 shows that at that time a preponderance of the mileage and membership (42.7 and 38 per cent, respectively) represented in the association was in favor of 16 ties to the 30-ft. rail or 2,816 per mile of main track. During the six years since 1905 the railways seem to have increased the number, for the general average of rail-bearing area, shown by the replies to this year's letter, is about 40 per cent, whereas in 1905 it was about 35½ per cent. In 1905, however, 17 (2,992 per mile) and 18 (3,168 per

mile) ties per 30-ft. rail (bearing area of 38 per cent and 40 per cent, respectively, based on 8-in. ties) were in strong favor.

In 1905, 59 per cent of the mileage voting believed a 6x8x8 ft. tie was too small, whereas 96 per cent thought a larger tie not undesirable. Twenty-two sizes of crossties were in current use, with 47 per cent of the mileage and 48 per cent of the membership reported as using 6x8x8. There is no doubt that the sentiment is in favor of a larger tie, but the sentiment stage has not been passed.

The length of tie apparently has not been considered so much as width and depth. In 1905, of 139,029 miles represented, 25,112 miles or 18 per cent reported ties 8 ft. 6 in. in length. The length of a tie between recognized limits has a great influence on the distribution of the superimposed load over the ballast and consequent tie crushing as well as the amount of maintenance work required with poor ballast, poor

Effect of Derailment on Steel Ties on Bessemer & Lake Erie Near Queen Junction, Pa.

sub-grade, or both. Ten and three-tenths per cent reported in favor of a 7x9x8 ft. 6 in. and none in favor of a 6x8x8 ft. 6 in.

The committee has been unable to find any data in the publications of the association bearing on the crushing strength across the grain of the various woods used for tie purposes, except that it is lightly touched upon on pp. 853-4, Volume II, Part 2. Table 1 gives the average of tests for various woods to show the effect of preservative treatment on crushing strength at the elastic limit.

The natural crushing strength at the elastic limit given in Table 1 does not compare favorably with similar results obtained by the United States Government. The director of the Forest Products Laboratory, Madison, Wis., furnished the sub-committee blueprints showing crushing strength at the elastic limit of timber—air dry and green, from which Table 2 is extracted. This table illustrates well why green timber for ties should be shunned.

The committee was of the opinion that further investigation should be made to ascertain the relation of tie spacing to different depths of ballast.

O. E. Selby, in Bulletin 80, October, 1906, treats of the stresses in ties. His recommendation is 12 in. of stone ballast directly under tie, superimposed on 12 in. of gravel, with ties spaced 20 in. center to center (45 per cent.).

Thos. H. Johnson's formulæ for depth of ballast and tie-spacing for gravel and stone ballast appear in Bulletin 76, June, 1906.

Conclusions.

So far as the committee is able to determine it is not feasible to lay down any fixed rule for the size and spacing of ties based on the A, B and C classification of density of traffic, for the following reasons, each of which in itself has a certain definite restriction, as well as an interrelation with all others, viz.:

(1) Character of sub-grade varies radically on the same road and in different parts of the country.

(2) Kind of ballast varies widely.

(3) Necessary depth of ballast varies with weight of axle loads, as well as density of traffic.

(4) Necessary distance between face of ties varies with weight of axle load, as well as density of traffic.

(5) Kinds of timber used for ties vary in different sections of the country.

(6) Width of base of rail, or weight of rail, and use of tie-plates.

(7) Treated or untreated ties, crushing stress and durability.

(8) Amount of labor spent on track maintenance.

(9) Drainage.

However, in general it may be considered good practice for Class A and perhaps B roads to space ties 10-in. to 12-in. face to face; the width of tie is not so important if 10-in. to 12-in. spacing face to face is followed; provided, however, the minimum width of face of tie is limited to 7 in.

TIE RENEWALS IN CONTINUOUS STRETCHES VERSUS SINGLE TIE RENEWALS.

The sub-committee appointed to investigate the comparative merits of "Tie renewals in continuous stretches versus single tie renewals" issued the following letter to the heads of the proper departments of the principal railways operating in the United States and Canada:

"It is desired to obtain information as to the comparative merits of "Tie renewals in continuous stretches versus single tie renewals." Will you kindly give us your practice and opinion in reply to the following questions:

"(1) What is the practice of your road in renewing ties; tie renewals in continuous stretches or single tie renewals?

"(2) Do you think it advisable to renew ties in continuous stretches?

"(3) What would be the advantage of this latter method of tie renewals?

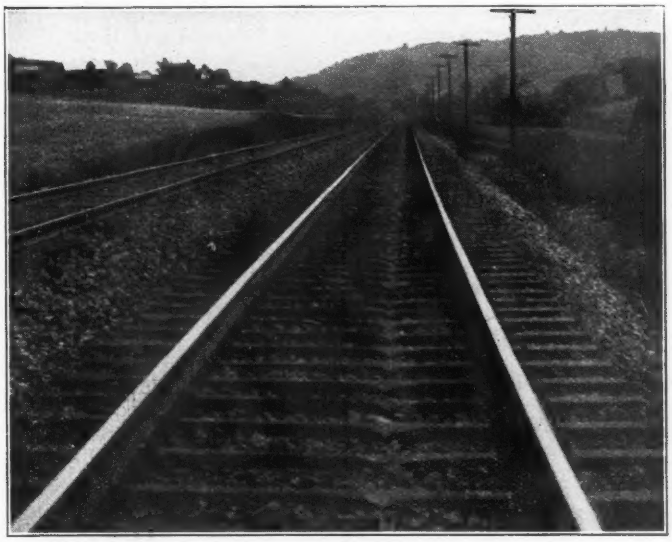
"(4) What are the advantages or disadvantages of single tie renewals?

"(5) Which practice would you recommend?"

Fifty of these letters were sent out and 35 replies were received. All who replied gave the subject the most careful attention, and thereby furnished the committee with some valuable information. Among the replies received were the following:

George W. Kittredge, chief engineer, New York Central & Hudson River:

1. The practice of our road is to renew ties under the method termed "single tie renewals."



Effect of Derailment on Steel Ties on B. & L. E. Near Jamisonville, Pa.

2. No.

3. There are no advantages in renewing ties in continuous stretches, except that possibly for the first year or two you might get better track than by renewing singly.

4. The advantages of single tie renewals far outweigh the disadvantages; in fact, I know of no disadvantages. The advantages are:

(1) You are able to let a single tie remain in the track until entirely worn out, since it has the advantage of the ties on each side of it being sound.

(2) The track is always kept safe by having a large proportion of good and comparatively new ties in the track. With continuous renewals there comes a time when, even before the ties are entirely worn out, the track is not safe, and, in order to maintain safety, it is necessary to take the ties out of track before they would, under other conditions, need to be removed, thus shortening their lives.

5. Unhesitatingly I recommend the practice of single tie renewals.

F. S. Stevens, engineer maintenance of way, Philadelphia & Reading:

1. The practice of our road is to "spot in" or renew only such ties as will not do their work another year on account of being too soft to carry the load.

2. Yes, if the track where ties are to be renewed can be taken out of service while work is being done.

3. Advantages of this method are: That by doing this work without interruption the labor costs less, by removing the ballast to sub-grade and forking it back, dirt is removed and good drainage restored. By retamping on fresh ballast the greatest trouble is removed; i. e., the constant care of looking after and retamping "spotted in" ties for about two years after being placed in track.

4. The sole advantage of "spotting in" ties where track can be taken out of service while renewals are being made, is that when ties have been taken out of track they are very liable to be wasted or destroyed prematurely. If track cannot be taken out of service to permit tie renewals without interruption, the increased cost of labor to renew "out of face" makes this method prohibitive. Therefore, under these conditions the "spotting in" method is most economical. As far as consistent with economy, ties should then be renewed in pairs, as labor costs nearly as much to renew one tie as two. In any event, ballast should be renewed at same time with ties, as this will make good drainage. This is important, for, unless air can reach the under side of ties, water will, and then trouble begins in earnest.

5. Under the conditions which we generally have to work I recommend the practice of "spotting in." However, when conditions permit I would renew ties "out of face" and would place every tie which will render further service in some track where its remaining life will be used to best advantage.

	Natural		Treated		Remarks
	No. of Tests	Crushing at E. L.	No. of Tests	Crushing at E. L.	
Red Oak	4	1090	4	1080	
Loblolly Pine	5	612	5	591	1. Crude oil, 529.
Shortleaf Pine	3	640	3	618	1. Crude oil, 373.
Longleaf Pine	2	688	2	725	
Red Gum	3	830	3	791	1. Crude oil, 655.

Crushing Strength of Various Woods, Treated and Untreated.

C. W. Johns, engineer maintenance of way, Chesapeake & Ohio:

1. Until recent years it has been the practice of this road to renew ties in continuous stretches. For the past two or three years we have tried to get all of our section foremen on double track to work one track one year and the other track the next, putting in single ties where required. On single track the foremen work half the section one year and the other half the next, putting in single ties where required.

2. No. This method necessarily allows a portion of the track to become unsafe before the ties are renewed; at least, the ties get so soft it is impossible to maintain good surface, while by slipping in single ties this condition does not exist and there are always sufficient sound ties under each rail to maintain proper surface and gage.

3. I know of no advantage of renewing in continuous stretches.

4. Advantage of this method is that you never have any stretches of rotten or unsound ties and there are always enough sound ties to maintain proper surface and gage.

5. I prefer the single tie renewals.

W. C. Cushing, chief engineer maintenance of way, Southwest System, Pennsylvania Lines:

1. The practice on our Lines is to renew ties as worn out or decayed, and not in continuous stretches.

2. No, except, possibly, between station platforms or in street crossings where the labor of getting at the ties is great.

3. I believe the following advantages might be claimed for the method of renewing in continous stretches: (1) Track could be given uniform lift, and, when new ties were in place, uniform support would be furnished them; (2) Cost of laying in continuous stretches would probably be less than laying them singly.

4. Advantages of single tie renewals are: 1 The track, as a whole, is kept in a more uniform condition, as to the quality of the supporting ties; (2) Only ties that should be removed, account of wear or decay, need be removed. Disadvantages of this method are: (1) The old bed of the tie must be dug up to get the new tie in place, or entire track given sufficient raise to accomplish this result; (2) Where platforms, planking or interlocking fixtures must be disturbed to remove ties, this disturbance takes place oftener under the single tie renewal system; (3) The cost of renewal per tie is probably somewhat higher under this system also.

5. We would recommend the renewal of ties singly. Because: (1) The general safe condition of the track is greater; (2) The average life of the ties, we believe, will be lengthened by the single tie renewal method, as, when renewing in continuous stretches, many ties are necessarily taken out and lost which might safely be left in the track a year or two longer if the adjoining ties were good.

W. L. Breckinridge, engineer maintenance of way, Chicago, Burlington & Quincy:

1. We practice the system known as "single tie renewals."

2. No, except in special cases.

3. Only advantage I know of in renewing in continuous stretches is in cases where the life of the rail under heavy traffic about equals the life of the ties; that is, in renewing rail where the traffic is heavy, ties should be renewed in full and unless ties under old rail are almost new, they should all come out. You will then have a track which will not have to be disturbed during the life of the new rail on account of tie renewals.

4. Single tie renewals is all right, especially, on less important main lines where the life of the rail exceeds that of the tie. We are also able to keep yearly check on our gage and hold a track to a more perfect gage, since the average efficiency of a proper single tie renewal track is almost constant, while with a continuous renewal track the holding power of spikes and general efficiency is on the decrease. Disadvantages of single tie renewal are: (1) Frequent disturbance of roadbed; (2) Inability to get a firm and equal bearing on the new ties; (3) Taking up too much time in the spring for this sort of work when the track needs picking up; (4) Keeping right of way littered each year with new and old ties.

5. I would recommend continuous renewal only when relaying rail on main line heavy traffic road. In such cases the life of the rail does not exceed that of the ties. In all other cases I recommend single tie renewal, as the life of tie timber varies too much to consistently renew in continuous stretches.

W. J. Towne, engineer of maintenance, Chicago & Northwestern.

1. Tie renewals based upon actual condition of tie, except joint and center ties; these are usually renewed together, and if any ties removed are serviceable elsewhere, they are properly utilized.

2. No, not as a general proposition. In slag or rock ballast I think it economy to renew continuous to the extent that any ties that will not last two years or more be taken out.

3. Principal advantage would be in securing more uniform rail bearing and economy when the life of the tie would not offset the labor charge for renewal and less disturbance of track bed result in general economy, in rail, etc., as well as improved roadbed.

4. Advantage of single tie renewals consists wholly in conservation. Disadvantages mentioned in reply "three."

5. Depends on character of line, volume of traffic, ballast, rail and roadbed. In gravel ballast with light traffic would recommend single tie renewals; in rock or slag ballast with heavy traffic would recommend renewal joint and center ties together, and renewal of all ties that would not last two years, both as a matter of economy and other reasons before named.

F. R. Layng, engineer of track, Bessemer & Lake Erie:

1. Single tie renewals.

2. No, I do not think it advisable to renew in continuous stretches.

3. The cost of renewals per tie (labor only) would be less when ties are renewed "out of face." This is on account of the fact that only about half as much ballast per tie would have to be dug out to make renewals. Disadvantage: In renewing in stretches, when it is decided that renewals should be made, track is in weakened condition. This being so, chances are either taken to run the ties a little longer, or, if the responsibility rests with a man who is timid, renewals are ordered at a time when most of the ties would last two or three years longer, if not disturbed. Neither of the above conditions tends to good practice. The ideal, to my mind, is to get the longest possible life from a tie, consistent with safety, without disturbing it.

I am quite sure the tendency of the average man would be to remove the ties in ample time so that the result would be to reduce the life per tie to about five years. This would increase the cost of tie renewals from 15 to 20 per cent. Inasmuch as tie renewals make up the largest single item in maintenance expense, most roads would hesitate to increase same unless some very decided advantage resulted therefrom.

Another disadvantage: It is practically impossible to select ties which would decay so uniformly that any great length of

track could be renewed without taking out some ties still fit for service. Some use would have to be found for these ties and they would no doubt be used in sidetracks. Assuming the following:

Cost of first-class tie delivered along track...$0.70
Cost of second-class tie delivered along track .60
Average life of first-class tie in main track..7 years
Average life of second-class tie in siding..7 years
Average life of first-class tie removed from main and used in siding...............3 years

We arrive at the figures given below:

Cost of tie removed from main and put in siding 3 years at 10 cents per year......$0.30
Cost to remove from main track.......... .03
Cost of putting in siding................. .08

Total cost $0.41
Average cost per year in siding..........$0.13 2-3
Cost of second-class ties..................$0.60
Cost of putting in siding................. .08

Total cost $0.68
Average cost per year in siding..........$0.09 5-7
Cost of first-class tie in siding............$0.70
Cost of putting in siding................. .08

Total cost $0.78
Average cost per year in siding..........$0.11 1-7

The above shows clearly, if my assumption is correct, that it does not pay to remove ties from main track to be used in sidings.

4. Advantages of single tie renewals: (1) Effective life of tie is longer; (2) Average condition of track as to safety is better; (3) Single track renewals disturb roadbed less; (4) Trackmen can arrange work to better advantage in single tie renewals; (5) Cost of tie renewals considerably in favor of single tie practice. (Net cost, including everything connected with this item.)

Disadvantages: I can see no particular disadvantage in the method of renewing ties singly. The most expensive thing we have is labor and least amount of labor per tie is expended.

5. Usual argument against single tie renewals, I presume, is that after making same, track does not ride smoothly or is spotty. This is usually the case, but it is the result of poor maintenance and is not a necessary evil which follows the practice of single tie renewal. If the trackmen will properly tamp new ties a week or ten days after they have been put in, this trouble can easily be taken care of.

From the information received it is evident that the general practice is to renew ties singly, except in unusual cases at station platforms, highway crossings, narrow tunnels or interlocking plants where it requires much labor to get at the ties or to uncover them for the purpose of renewal.

Conclusion.

The committee recommends the practice of single tie renewals.

METAL, COMPOSITE AND CONCRETE TIES.

The committee was directed to prepare a report on the use of metal, composite and concrete ties.

In connection with the following report the committee wishes to point out that it is of the opinion that no single design of substitute is going to meet all the conditions to be found on railway track and there should be at least two designs or types, one for heavy service, and the other for light service, both to be insulated or not, as required.

It is desirable that any type of non-insulated tie should be capable of being insulated without having to be removed from the track. As far as we can see, very few designers have recognized this distinction and as a result attempt to meet all conditions with a single design. We believe this is neither desirable nor economical, and that much better results will be obtained if the tie be designed for special service.

The committee has been somewhat disappointed with the results obtained with the concrete tie, the concrete and metal tie and the asphalt and metal tie, for reasons given in our conclusions.

In regard to steel ties, the committee was impressed with the number of steel ties in use on the Union Railroad and the Bessemer & Lake Erie. The total number of steel ties on these two roads is over one million, or enough to lay 312 miles of track, using 3,200 ties to the mile.

We desire to call attention to the widespread interest that is now being taken in finding a substitute for the wooden tie. This is not confined to any particular section of the country, nor to the steam railways.

In addition to the personal inspection made by the committee, reports have been received from railways using substitute ties, among which are the following:

Bessemer & Lake Erie Railroad:

"Up to January 1, 1911, this company had purchased 563,555 Carnegie steel ties and during 1911 we will receive 138,000, making a total of 702,355 ties to be received by January 1, 1912. The ties if laid continuously 3,200 to the mile (our standard spacing on main line) would give 219.5 miles of steel tie track. During the year we also received 20 sets of steel switch ties.

"We have very little, if any, additional information to report this year. The ties put in at Claytonia in 1904 are still in and there has been no change in their condition since our last report. The 1,000 insulated ties installed in June, 1906, at Conneaut, Ohio, are still in and have given no trouble whatever.

"This road will continue to use this type of steel tie in maintenance and construction work.

"Accompanying this are two photographs, one showing scene of a derailment near Queen Junction, Pa., and one near Jamisonville, Pa. Both derailments were caused by a broken flange; in each case but one pair of trucks was derailed and the car derailed was a steel car loaded with 55 tons of ore, so that the gross weight of the car was about 73 tons. These derailments happened in August, 1910, and the ties are still in the track."

Species	Air Dry					Green				
	Compression Vertical to Grain					Compression Vertical to Grain				
	Stress Area, In.	Height, In.	No. of Tests	Per cent Moist.	Cr. Str. of E. L. lbs. per sq. in.	Stress Area, In.	Height, In.	No. of Tests	Per cent Moist.	Cr. Str. of E. L. lbs. per sq. in.
1. Longleaf Pine....	4x5	4	22	25.1	572	4x4	4	22	25.3	568*
2. Douglas Fir......	4x8	16	44	20.8	732	4x8	16	259	30.3	570
	4x8	10	32	18.1	584					
	4x4	8	51	20.2	638					
	4x4	6	49	24.0	613					
							(Fire	killed)		
	4x4	4	29	24.8	603	6x8	16	24	33.7	368
3. Shortleaf Pine...	8x5	16	4	17.8	725	5x8	16	12	37.7	361
	8x5	14	3	16.3	757	5x8	14	12	42.8	366
	8x5	12	5	15.1	730	5x8	12	24	53.0	325
	5x5	8	6	13.0	918	5x5	8	24	47.0	344
	2x2	2	57	13.9	926	5x2	2	277	48.5	400
4. Western Larch...						6x8	16	22	43.6	417
						6x8	12	20	40.2	416
						4x6	6	53	52.8	478
						4x4	4	30	50.4	472
5. Loblolly Pine...	8x5	16	12	19.8	602	8x4	8	16	67.2	392
	8x5	8	7	22.9	679	4x4	8	38	44.6	546
	4x5	8	8	19.5	715					
6. Tamarack.......	2x2	2	57	16.2	697					
7. Western Hemlock	7x6	15	25	18.2	514	6x4	6	30	48.7	434
	6x6	6	26	16.8	431					
	4x4	4	6	15.9	488					
8. Redwood........						6x8	16	13	86.7	473
						6x6	12	14	83.0	424
						6x7	9	13	74.7	477
						6x3	14	13	75.6	411
						6x2	12	12	66.5	430
						6x2	10	11	55.0	423
						6x2	8	12	56.7	396
						2x2	2	186	75.5	569
9. Norway Pine....	2x2	2	36	10	924					
10. Red Spruce......						2x2	2	43	31.8	310
11. White Spruce....						2x2	2	46	50.4	270

* Partially air dry

Crushing Strength of Timber at the Elastic Limit.

Cornwall & Lebanon Railroad:

"With reference to our experience with the 200 Snyder steel ties which were installed in our road about five years ago, these ties are located on the southbound track of our double track, lying about one mile west or south of Mount Gretna in a two-deg. curve and on a 1.5 per cent. descending grade. One coat of tar paint was applied when the ties were put in and another coat during the past year. This is about the only expense we have been put to in the matter of maintenance.

"A few months ago in passing over this part of the road it was noticed that the asphalt concrete filling showed signs of disintegration at the open ends of the ties and upon investigating we found as far back as the hand could be placed that the filling was loose and in particles. In order to ascertain how far in this extended the tie was taken out of the track and in pulling the tie out the filling was left on the ground under the rails, simply a mass of particles. We imagine that as a result of this condition whenever the ties are tamped some material will be dropped from the bottom through the slight raising due to the tamping. The track foreman reported that he had noticed the material loosened in this manner several months ago. The track at this point is laid with 80-lb. rail and on stone ballast.

"Approximately half a million tons of freight per year pass over this track in the southward direction, our heaviest locomotives being 75 tons in weight, not including the weight of the tender. During the summer season eight or ten passenger trains pass over this track daily and four passenger trains the remaining portion of the year, probably at a speed of 40 or 50 miles per hour.

"There has been no trouble at all in connection with these

ties as stated, except the recent crumbling of the asphalt filling. Just what the effect of this would be eventually we are not prepared to say."

Duluth, Missabe & Northern Railway:

"We have about 22,400 ties of the Carnegie Steel Company's Section M-21. They were purchased in the summer of 1908 and we started to put them in the track in the fall after the ore business closed, but the work was not completed until the spring of 1909. Two miles of these were placed on the hill between Duluth and the yards at Proctor, being placed in the double track, one mile in each track. This portion of the road had been previously ballasted with crushed granite and consequently required less work to place them than it did the others, which were placed where the track crosses the big muskeg swamp about 50 miles north of Duluth. This is also double track and we have two and one-half miles of these ties in each track. This portion of the road had been ballasted with gravel and had always cost us a great deal to maintain during the summer season on account of the nature of the soil underneath the roadbed. It was necessary to keep the track lined with men during the ore season to keep the track in shape and to keep the rails spiked to line, although we were using tie-plates, but owing to the shaking and trembling of the ground underneath which set up a vibration in the train the rails were continually spreading and it was necessary to line spike this track every season, and more or less would have to be lined up two or three times during the summer.

"We removed the old ballast and replaced it with crushed granite, leaving the original roadbed underneath the granite sloping from the center between the two tracks. Owing to this work having been done in the winter when there was a great deal of snow on the ground and more or less ice, these tracks required considerable attention during the summer of 1909, but by the time winter set in they were in elegant shape and during the summer of 1910 we did no more work on them whatever. Of course, the section men passed over them going to and from their work, but no work was done in either surfacing or lining during the entire summer, which was something very unusual for that track. It kept in very good shape until late in the fall, at which time by careful inspection you could see that some places were slightly depressed, but it was scarcely noticeable in the running of trains. Early in the season of 1911 we sent an extra gang over this track and brought it to surface again. Since that time no work has been required on it, although we have had a large amount of rain in that district this summer.

"We would say that with these ties, placed 18-in. centers as we have them, carrying 100-lb. rail, it is impossible for a small section crew to line and surface the track to a great extent, but needs a small extra gang to handle it, as it is exceedingly heavy and hard to move. However, it requires so much less attention than our old track with the wooden ties and 80-lb. rail that we feel there is economy in the use of these ties, notwithstanding the difference in first cost of the steel and the wood.

"The two miles on the hill between Duluth and Proctor have required scarcely any attention since they were put in place, but the soil underneath the roadbed at this point is solid clay and has never caused the trouble the tracks across the big swamp have. There are two light curves on the latter two miles and we have worn out the new rail which was placed with the ties in some instances on these curves, but the cost of surfacing and relining the track has been very light as compared with the tracks on the wooden ties."

Lake Shore & Michigan Southern Railway:

"At one time we had steel ties on several divisions of the road in experimental stretches, but a few years ago they were all taken out. One of the chief troubles we had with them was the insulation. A number of them have now been put in on our Sandusky pier branch where the speed is limited, and we have no need of insulation, and where we run in streets part of the way and good permanent construction is needed. They are well adapted for this service.

"These ties are mostly of the Buhrer pattern, made by the Carnegie Steel Co., with four clip fastenings for each tie. They have been in track for about six years and are in first-class condition at this time. The roadmaster is of the opinion that they will last from ten to fifteen years longer. They hold the track in line, surface and gage very well, but our people are not yet convinced that they are the tie for our main line with its heavy high speed traffic."

Pittsburg & Lake Erie Railroad:

The following is the cost of maintaining Carnegie steel ties which were installed August, 1907 (bolt and clip fastenings), as compared with a like stretch of wood ties:

Calendar Year.	Length of Experimental Track Section.	Carnegie Steel Ties, Cost of Labor.	White Oak Ties, Cost of Labor.
1908......	4,400 ft.	$280.00	$417.00
1909......	" "	153.00	95.00
1910......	" "	428.00	128.00
1911......	" "	184.00	116.00

These experimental sections of track were built with new material and new limestone ballast in 1907. The maintenance record begins with the calendar year 1908.

These ties were laid in the main line freight tracks, equipped with electric circuits in connection with automatic signals. Tracks are used by freight trains only, which run at a speed of about 30 miles per hour.

During 1911 it was necessary to resurface the steel tie track three times and the white oak track once. During the year 1911, fiber plates were removed from track on account of being cut by rail base. Twenty bolts in steel tie clips were found to be loose.

It is now 52 months since these steel cross-ties were laid in the track and the record of the insulations shows that no fibers were renewed previous to 1911, and in that year only 17 were found defective. There has been, practically speaking, no signal trouble whatever.

Conclusions.

The committee respectfully submits the following conclusions:

1. The concrete tie, a combination of concrete and metal tie, or a combination of asphalt and metal tie has not yet proved a success because of fracture caused by vibration, excessive weight and consequent difficulty in handling, and deterioration of asphalt filling.

2. A combination tie of steel and wood gives promise of developing an economic substitute.

3. The all steel tie has proved a satisfactory substitute for the wood tie under heavy medium speed traffic. It is durable; line and surface can be maintained, has sufficient resiliency and can be insulated. The fastenings so far in use can and no doubt will be improved.

The report is signed by L. A. Downs (I. C.), chairman; G. W. Merrell (N. & W.), vice-chairman; H. W. Brown (P. L. W.), W. J. Burton (M. P.) L. C. Hartley (C. & E. I.), E. D. Jackson (B. & O.), F. G. Jonah (St. L. & S. F.), H. C. Landon (Watauga R. R.), F. R. Layng (B. & L. E.), D. O. Lewis (C. N.), Duncan MacPherson (Transcontinental), L. M. Perkins (N. P.), J. G. Shillinger (C. C. C. & St. L.), G. D. Swingly (B. & O.), D. W. Thrower (I. C.), H. K. Wicksteed (C. N. Q.), H. S. Wilgus (P. S. & N.).

Discussion on Ties.

L. C. Fritch (C. G. W.): It occurs to me that the committee has left out a very important consideration in regard to the stresses to which ties are subjected. I think they should give us some information on what stresses ties are really being subjected to with our heavy wheel loads. Before we adopt these conclusions we ought to have some information on that line. The conclusions given are not definite and they do not give much information except in the last paragraph and I doubt very much whether all the members of the association will agree with the committee on that clause. There are many members who think that the width of the tie is an important question, even if the spacing is 10 to 12 in., and it occurs to me that the conclusions as they now stand are hardly suitable for adoption.

Mr. Downs: The first nine paragraphs of the conclusions are restrictions, rather than conclusions. The last paragraph is a conclusion that the committee saw fit to make, after taking into consideration the nine reasons why a fixed rule cannot be set for A, B and C traffic. It is a very hard matter to determine the stresses in ties, and we enumerated nine objections, after carefully considering the proposition, as to why a fixed rule cannot be adopted for the railways to follow.

Mr. Fritch: In designing a bridge we assume a certain load, and I think the time has come when we should pay more attention to the designing of track structure, just as we do to the designing of the bridge structure. We should assume certain heavy wheel loads and ballast conditions and design the track structures to conform to these, just as we do in the case of the bridge structure. I assume that this is an important subject for the railways. I am of the opinion that many of us think that the ties are too small, and are being subjected to too heavy stresses, and we should have more information on that line.

Mr. Downs: In designing a bridge, you have an absolute

foundation, which is solid. You build the abutments and design the bridge for certain wheel loads. You have absolutely known factors to work on. In designing a track structure you must figure on subgrade which is an uncertain quantity. As we enumerated in these nine paragraphs, we cannot lay down any fixed rule on account of the nine reasons given—the kind of ballast varies, the depth of ballast varies, the kind of timber used for ties varies, and there are various other reasons.

Mr. Fritch: We can assume conditions which we can hope to reach. While the bridge structure is a different proposition, the principle is the same. We can assume certain conditions of ballast, foundation and load, and design the rest of the structure accordingly.

J. L. Campbell (E. P. S. W.): Many of the railways are still carrying their track across steel bridges and wooden bridges on wooden ties, and it seems to me if we should assume the conditions which undoubtedly exist, or nearly exist on the bridges, we might arrive at some conclusions along the lines which Mr. Fritch suggested. I believe it would be a good thing to determine just what the unit stresses are in a case of that kind.

Mr. Morse: It seems to me we should not put anything in the manual except what would be of particular benefit. As I understand the conclusion offered by the committee, it practically gives no recommendation at all.

Mr. Lindsay: Assuming a stable condition of subgrade and a desirable condition of ballast, the maximum spacing of the ties would be determined by the height of rail and the weight of it. The minimum condition would be established largely by the method of track work and kind of tool used for tamping. Between these two conditions there would be a wide range of possibilities. I believe it is possible to assume a set of conditions and determine with reasonable accuracy what is the best type of construction.

The President: In assigning this subject to this committee the Board of Direction had in mind that the report would be made on two lines, one line which the committee has reported on and the other line in harmony with what Mr. Fritch has stated. We knew when the subject was assigned that it required a number of assumptions to come to conclusions. A great many European engineers have already made studies on this line, and the Board thought it was about time that the engineers in this country took it up and tried to furnish some additional light on the subject.

The Board feared in going over this matter yesterday that a misinterpretation of the subject had been made by the committee, and they, therefore, proposed a rewording of the instructions in line with what Mr. Fritch has already stated, namely, that they would like to have a study of possible stresses in the ties, and from that work to a possible design or size for a tie.

The committee admits that they have been unable as yet to draw any conclusion from the collection of facts sent by the railways. It is, therefore, a very interesting subject for the committee to pursue, and the Board would very much like to have the committee do that if the association after this explanation feels that it is a good thing to do.

The motion to adopt the committee's conclusion was lost.

Mr. Fritch: I move this portion of the committee's report be referred back to it for further consideration; that it be received as information as at present submitted, and that the committee give additional study to the subject along the lines of the remarks on the subject. Motion carried.

Mr. Downs: The second subject referred to the committee was "Tie Renewals in Continuous Stretches vs. Single Tie Renewals." I move the adoption of the conclusion, viz., "The committee recommends the practice of single tie renewals."

Hunter McDonald: I rise with a good deal of timidity to take issue with the committee. I did not receive the committee's circular. If I had done so, what I have to say now would have been printed in their report. I do not think the fact that it is the common practice in this country is sufficient reason to adopt this method of tie renewal as the policy of the association. The replies received by the committee to its circular and the statements of the committee, do not show that there have been any very deep investigations as to cost and other factors. They simply express the opinion that it is the best policy without giving any facts to back up that opinion. I think this habit of single tie renewals has grown up because of a condition of affairs for which none of us are responsible. The managements of the railways are unwilling to incur the initial expense necessary to introduce any other policy. If it should be shown to be desirable to have 12 inches of ballast under the track, and the ties all put in at one time, on a given stretch of track, so that it would require very little work to be done for five or six years, it would entail necessarily a large initial expense, which would continue until the entire division had been so overhauled. After that time I am firmly convinced that the cost of maintaining the track would be very much less than it is under the present policy.

Another reason why this habit has grown up is because of the waste of ties that occurs under this renewal plan. There would undoubtedly be ties in the track that would last at least two years, and the roadmaster would criticise the section foreman for taking them out. On the other hand, if such ties were left in the track, in order to secure the additional length of life, which would probably represent 30 cents in value for each tie, I believe it would require at least $1 in labor to keep the tie in condition. This is a concealed loss.

I realize that this problem is one that depends on a good many indeterminate conditions, among which are the life and price of ties, cost and efficiency of labor, density of traffic, depth and care of ballast, care of the underlying roadway and the standard of excellence to which the track has to be maintained. I have endeavored to ascertain what the labor costs are for maintaining the track in accordance with the plan recommended by the committee. I have sought from our own accounts and from those of other roads to find it out. I have found an utter lack of uniformity in the method of keeping accounts and it is simply impossible to make any comparison between the present method and any other method. I think we need a much closer analysis of our labor costs than we are now securing under the I. C. C. distribution of costs. I think it would be well for our Committee on Accounts to endeavor to formulate some standard subdivision of roadway and labor costs in order that we may arrive at some definite knowledge by which we may compare these things.

For the past eight or ten years one of our roadmasters had been very diligent in observing the small amount of labor required to maintain stretches of track on which all the ties had been renewed at one time and he was so much impressed with the reduction in the labor cost that he received permission to try one experimental mile, which was put in in 1908. We were paying 40 cents for first class white oak ties. The track was laid with 80-pound rails, and had 53.5 per cent of 2 deg. curves running in opposite directions, with 450 ft. of tangent between them. The grades were slightly undulating There was an annual freight tonnage of 2,000,000 tons, with ten regular passenger trains per day, running at a speed of 75 miles an hour. The heaviest freight engines weigh 346,000 pounds, with a maximum axle load of 48,300 pounds. The heaviest passenger engine weighs 314,000 pounds with a maximum axle load of 51,300 pounds. There are nine inches of clean ballast under the track and a three-inch additional lift was given. The cost was:

3,000 ties at 40 cents	$1,200.00
1,263 cubic yards of ballast at 50 cents	631.50
Labor putting in ties and ballast and dressing up	844.00

Total $2,675 per mile.

A close account has been kept on the cost of maintaining this mile of track. The section foreman has been given special instructions to report each month the amount of labor expended in maintaining this track to surface. For the first year the cost was $23; second year, $29.80; third year, $35.20. We have just gone through the winter of the fourth year. We estimate the expense for the fourth year not yet completed will be $50; the fifth year not to exceed $75; and the sixth year, $110. In other words, we do not expect to renew any of the cross ties in that mile of track inside of six years. This opinion, I think, is borne out by a committee of engineers from an eastern road who visited our line. The cross ties are all of first class white oak. The average cost of maintenance of the track per year would be $53.83.

Assuming that this track would run six years without any serious overhauling, one-sixth of the initial expense to put it in would be $445.83, and with the estimated annual expense for maintenance of $53.83 the average cost per year per mile would be $499.66.

We do not know how this compares with results on other roads or even on our own line. We hope, however, to be able to tell you something about it in the near future. Since this mile was put up the results have been very flattering and we are now carrying out the same policy on 45 miles of track on that division.

From the best information I can get I believe the annual cost of carrying out the policy recommended by the committee, putting the price on the same basis, would be about as follows:

Ties	$154.44
Labor putting in	77.22
1½ in. of ballast every two years	118.50
Labor surfacing and applying ballast	250.00
Labor of maintaining	100.00
Total	$700.16

This, as you see, would make a difference of about $200 a mile. Naturally, we assume that the ballast is clean to start with. I have taken no account of the fact that at the end of the first six years the necessary raising of the ballast, after it is overhauled again, would not require as much as 3 in., and the annual cost would, therefore, be somewhat reduced.

We lack some standard method of comparing the excellence of our tracks. We can send out a dynamometer car, and get some idea as to what the surface condition of the track is, but if we could devise some simple method of comparing the condition of the tracks with some standard, it would greatly simplify the matter of comparing cost of maintenance.

Mr. Morse: On the Santa Fe we have a stretch of 55 miles of what we call an experimental track. Upon 22.5 miles we dug the track out and laid the ties to face, as Mr. McDonald suggests. We put in 12 in. of rock ballast, used creosoted ties, 3,200 to the mile, 90-lb. rail, and we have arranged our sections to have them divide at either end of this stretch, with an idea of keeping an account of the cost of renewals and repairs to see how it will compare with the renewal of ties individually. We expect to get at least ten years out of these creosoted pine ties. On the basis that our rail has to be renewed at the end of ten years, it has seemed to us that the proper way to carry on the renewal of ties would be to renew the face at the time you renew the rail.

W. L. Seddon (S. A. L.): I think the results mentioned by Mr. McDonald and Mr. Morse are predicated on a much more uniform basis than exists on the average railway, and that the committee's conclusions are based on the average results secured by the average railway. I think it is the uniform experience that, when a new track is laid, it is very much more expensive to keep this track in condition by renewing all the ties at one time than it would be to replace the ties one at a time. In the South, where we use pines ties and cypress ties, we begin to take out some of the ties from the track four years after the track is laid, while some of the ties remain in service fifteen years. I do not think it is fair to criticise the committee's results by comparing what they propose with track laid with selected ties or treated ties. I think the committee's conclusions are correct.

The motion to adopt the committee's conclusion was carried.

Mr. Downs: The third subject assigned to the committee was the use of metal, composite and concrete ties. I move that conclusion No. 1 be adopted.

Motion carried.

TRACK.

The subjects assigned were:

(1) Present general specifications covering material and workmanship for frogs, crossings and switches, including the use of manganese and other special alloys.

(2) Present general specifications for track bolts, nut locks, tie-plates, common track spikes and screw spikes.

(3) Study designs for main line turnouts.

(1) FROGS, CROSSINGS AND SWITCHES.

The committee has revised the plans for Nos. 8, 11 and 16 rigid frogs, No. 11 spring frog and for 11-ft., 16½-ft., 22-ft., and 33-ft. switches and submits them for adoption as general plans representing good practice. The committee has also revised and combined the "General Specifications for Frogs, Crossings and Switches" adopted by the convention of 1910, and the "General Instructions for Ordering or Contracting for Frogs, Crossings and Switches," submitted to the convention of 1911 and received as information, and submits them for adoption as representing good practice.

At the convention of 1909, the association instructed the track committee to recommend three standard lengths of switches and three standard numbers of frogs; such a recommendation was made, with the modification that a fourth length of switch was added for special cases requiring frogs of large angle; the recommendation was embodied in conclusion 4 of the committee's report, which was adopted by the convention of 1910, but was referred back to the committee by the board of direction for reconsideration.

The committee reconsidered and reaffirmed its former action; the conclusion was not resubmitted, however, excepting as the proposed lengths of switches and numbers of frogs were embodied in the "General Instructions for Ordering or Contracting for Frogs, Crossings and Switches" which was received only as information by the association at the convention of 1911.

In determining the lengths of switches the committee considered it necessary to provide for the following general classes of turnouts:

(a) Turnouts to be operated over the divergent route at the maximum practicable limited speed.

(b) Main line turnouts and crossovers to be operated over the divergent route at low speed.

(c) Yard turnouts.

(d) Turnouts requiring frogs of large angle.

The second point considered was the economical cutting of a 33-ft. rail; the question of using the full 33 ft. as one of the lengths of switch was very fully discussed by the committee at meetings held in three successive years. The main objections to the use of a 33-ft. switch are (1) the length being the same as that of the stock rail unless a special length of stock rail is used, one joint of the latter must necessarily come near the point of the switch and the other joint ahead of and near the heel of the switch, often necessitating the clipping of the angle bars, and (2) the great length of laterally unsupported rail.

The committee is of the opinion that the location of the joints of the stock rail 40 inches ahead of the point and heel of switch is not seriously objectionable and the clipping of the angle bars is not an expensive operation and does not seriously weaken the joint, and that switches 33 ft. and even 45 ft. long have been successfully used to such an extent that there seems to be little ground for apprehension on account of the length of laterally unsupported rail.

Twenty-seven ft. and 30-ft. lengths have been suggested in lieu of a 33-ft. length; the angles would be respectively 22 per cent. and 10 per cent. greater than that for 33 ft.

The longest switch points are to be used in those turnouts where the highest speed is desired. These switch points will necessarily get severe usage, therefore they should be made from the very best rail. If made from the second or third rail from the top of the ingot, you have eliminated as far as possible any chance of defect in the rail. These rails are as a rule 33 ft. in length. The lengths of switches recommended can be made from 33 ft. rails without any waste.

These and other considerations led the committee to recommend the following length of switch points for the four general classes of turnouts named above:

(a) 33 ft.; (b) 22 ft.; (c) 16½ ft.; (d) 11 ft.

A purely theoretical investigation of the rate of turning of a locomotive at the switch point and of the angle between the stock rail and a line passing through truck centers of a car leaving the switch indicates that an approximate balance between the deflection through the switch point and the deflection through the lead is attained when the switch angle equals one-fourth the frog angle. This proportion has been found to work out well in practice. It seems to be certain that when the switch angle exceeds one-fourth the frog angle, the switch point presents the worst feature in the alignment of the turnout and there is an economic loss both in the space occupied by the turnout out and in the cost of the turnout.

With a 6¼-in. heel distance and ¼-in. thickness of point, the above relation between switch angle and frog angle would make the length of the switch in feet equal to twice the frog number.

In 1908 the frogs most used appear to have been numbers 10, 7, 8, 9, 6, 15, 12, 20, 11, 14 and 16 in the order named; number 10 frogs being used by 55 per cent. of the roads tabulated and number 16 by only 5 per cent. But the roads using No. 11's included the Chicago, Burlington & Quincy, the Great Northern, the Michigan Central and the Northern Pacific and those using No. 16's the Baltimore & Ohio, the Erie and the Lake Shore & Michigan Southern.

No. 7 frogs are rapidly disappearing, being supplanted by No. 8's; the relative number of No. 10's is also diminishing, with a corresponding increase in the proportion of frogs of higher numbers.

It seems desirable for class (a) turnouts to use the highest number of frog which is economically consistent with the longest switch point; for class (b) the great preponderance of present practice is in favor of No. 10 frogs, but the choice of this frog would leave an unfilled gap between this and the highest number frog; besides, a No. 10 turnout with a 16½ ft. switch is little better in its worst feature than a No. 8 turnout with the same switch, while a 22-ft. switch would unduly increase the degree of lead curve; for class (c) the trend of present practice, if not the preponderance of practice at this date, is in favor of No. 8 frogs; for class (d) no number of frog can be specified, as this class includes a multitude of special cases.

The committee presents its former recommendation in a modified form:

Switch points 16½ ft. long are recommended for frogs over No. 6 up to and including No. 10; 22-ft. points for frogs over

No. 10 up to and including No. 14; 33-ft. points for frogs over No. 14 and 11-ft. points for No. 6 and under where they are required.

Nos. 8, 11 and 16 frogs are recommended as meeting all general requirements for yards, main track switches and junctions; new work should be laid out, so far as practicable, for these three frogs, so as to effect the gradual elimination of frogs of other numbers, lessen the cost of manufacture and decrease the amount of stock carried.

(2) No attempt was made to prepare specifications for tie-plates and track fastenings, but the committee attempted to formulate principles as to the functions, material and form of tie-plates and track fastenings. The work has not progressed far enough at this time to be embodied in a report.

(3) The work of the committee on the designs of main line turnouts is necessarily held in abeyance pending the adoption of standard numbers of frogs and lengths of switches.

VERTICAL CURVES.

In order to get the benefits of experience in the use of vertical curves, a series of questions was asked members of the association and the replies tabulated.

Under apparently like conditions, widely different results were obtained; this leads to the conclusion that the conditions were only apparently alike and that there must be other unknown conditions. The data in its present form seems to give very little information of value. The committee will continue its investigations.

CONCLUSIONS.

The committee recommends:

(1) That the "General Specifications for Frogs, Crossings and Switches" be adopted as representing good practice.

(2) That the plans of No. 8, 11 and 16 rigid frogs, No. 11 spring frog and 11 ft., 16½ ft., 22 ft. and 33 ft. switches be adopted as general plans representing good practice.

(3) That the committee's recommendation as to lengths of switches and numbers of frogs be adopted.

J. B. Jenkins (B. & O.), chairman; G. J. Ray (D. L. & W.), vice-chairman; Geo. H. Bremner (C. B. & Q.), A. Bruner (N. & W.), Garrett Davis (C. R. & I. P.), Raffe Emerson, E. G. Ericson (P. L. W.), J. M. R. Fairbairn (C. P.), T. H. Hickey (M. C.), J. R. Leighty (M. P.), Thomas Maney (L. & N.), Curtiss Millard (C. G. W.), P. C. Newbegin (B. & A.), R. M. Pearce (P. & L. E.), H. T. Porter (B. & L. E.), W. G. Raymond (Iowa St. Coll.), S. S. Roberts (I. C.), L. S. Rose (C. C. C. & St. L.), R. O. Rote (L. S. & M. S.), H. R. Safford (G. T.), F. A. Smith, C. H. Stein (C. R. R. N. J.), F. S. Stevens (P. & R.), W. J. Towne (C. & N.-W.), R. A. Van Houten (L. V.).

GENERAL SPECIFICATIONS FOR FROGS, CROSSINGS AND SWITCHES.

General Instructions.

The company will furnish to the manufacturer specifications and drawings. The drawings will show rail sections, splice drilling, angles, alinement, general dimensions and such details as the company may desire.

When requested, manufacturers shall submit for approval detail drawings showing construction and dimensions of all parts to be furnished in accordance with these specifications. Conventional shading shall be used in sectional drawings. All dimensions and distances shall be shown plainly in figures. The title shall be placed in the lower right-hand corner.

The detail drawings shall be on sheets 22 in. wide, with a border line ½ in. from the top, bottom and right-hand edge, and 1½ in. from the left-hand edge. The standard length of sheets shall be 30 in. except that, when necessary, longer sheets may be used and folded back to the standard length. Drawings of one subject only shall appear on a sheet. Scale of general drawings shall be 1½ in.=1 ft.; details not less than 3 in. = 1 ft.

The drawings of the company and the manufacturers' drawings approved by the company shall be a part of the specifications. Anything which is not shown on the drawings but which is mentioned in the specifications, or vice versa, or anything not expressly set forth in either but which is reasonably implied, shall be furnished the same as if specifically shown and mentioned in both. Should anything be omitted from the drawings or specifications that is necessary for a clear understanding of the work or should any error appear in either the drawings or specifications affecting the work, it shall be the duty of the manufacturer to notify the company and he shall not proceed with the work until instructed to do so by the company.

Inspection.

Material and workmanship shall be at all times subject to inspection by a duly authorized representative of the company, who will examine the material before it is worked in the shop. He will inspect the work during progress and will also inspect the finished product, with power to reject materials and workmanship found to be unsatisfactory. He shall have free access to the shops and mills at any and all times during the progress of the work.

The acceptance of any material by an inspector shall not prevent subsequent rejection if found defective after delivery or during the progress of the work and such defective material if furnished by the manufacturer shall be replaced by him at his own expense.

All facilities, labor and tools necessary for the shop inspection shall be furnished at the expense of the manufacturer.

When the manufacturer furnishes the rails, he shall supply the company with a certificate of inspection made by some competent person acceptable to the company.

Material.

Rail.—No. 1 rail, of the section ordered, as called for by the specifications, shall be used.

Fillers.—Fillers between the main and wing rails and between the main and easer rails shall be rolled steel. Throat filler blocks, not presenting a running surface, may be cast-iron.

Raiser Blocks.—Raiser blocks shall be hard cast steel.

Foot Guards.—Metallic foot guards shall be either cast-iron, malleable iron or cast steel, except that strap foot guards shall be rolled steel. Wooden foot guards shall be of best quality hard wood.

Bolts.—Bolts shall be of double refined iron or mild steel. Bolt metal shall have a tensile strength of not less than 50,000 lbs. per sq. in. and an elongation of not less than 15 per cent. in eight inches. When nicked and then broken, the fracture shall be free from flaws and unwelded seams.

Rivets.—Rivets shall be made of steel which may contain a maximum of 0.04 per cent. basic phosphorus, 0.04 per cent. acid phosphorus and 0.04 per cent. sulphur. It shall have an ultimate tensile strength of 50,000 lbs. per sq. in. It shall bend flat upon itself without fracture and when nicked and bent around a bar of the same diameter as the rivet rod it shall give a gradual break with a fine silky uniform fracture.

Reinforcing Bars.—Reinforcing bars shall be of wrought-iron or mild steel.

Plates.—Plates shall be of rolled steel.

Springs.—Springs shall be of the best quality spring steel and of dimensions and capacity shown on the plans. They shall meet the following tests:

(a) Each spring shall be placed on the testing machine and forced down solid four times.

(b) After the foregoing, each spring shall be placed on end on a flat plate, and the distance between the plate and the other end of the spring measured by means of the standard depth gage; this measurement being the free length of the spring. The free length must conform to the plans within ⅛-in.

(c) Double springs shall be assembled and a load at least 25 per cent. greater than the rated capacity of the spring shall be applied for thirty seconds. Upon release neither spring must vary from its original free length. If either one does so vary, it shall be rejected.

(d) The inner and outer coils of springs shall be coiled in opposite directions.

Spring Covers.—Spring covers shall be made of malleable iron.

Braces.—Braces shall be made of (insert "malleable iron" or "forged steel").

Stops and Hold-downs.—Stops and hold-downs shall be made of mild steel.

Anti-creeping Device.—Anti-creeping device shall be made of mild steel.

Switch Lugs.—Switch lugs shall be mild steel.

Switch Rods.—Switch rods shall be mild steel.

Workmanship.

Workmanship shall be first-class. All bends shall be made accurately in arcs of circles and without injury to the material. Welding will not be permitted in any part of the frogs or in the switch rails. Planing shall be such that abutting surfaces will fit accurately together. Ends of rails shall be cut at right angles to the axis of the rail except where otherwise specified. All burrs shall be removed.

No paint, tar or other covering shall be used before inspection.

The alinement and surface of all finished work shall be even and true, and shall conform to the angles specified.

Frogs.

Fillers.—Rolled fillers shall fit the fishing angles and the web of the rail for a distance of ½-in. above and below the base and head, respectively, and shall maintain the required flangeway. Throat filler blocks shall fit the rail sufficiently

well to maintain the required spacing. Where the brand of the rail interferes with the fit of the filler the brand shall be chipped off. Fillers shall be grooved or cut out to fit over rivet heads.

Heel Raiser Blocks.—Heel raiser-blocks shall fit the head, base and web of rail as provided under rolled fillers.

Foot Guards.—Solid foot guards shall fit the rail sufficiently well to maintain the required spacing. Strap guards shall have a minimum thickness of ⅜-in., of the width shown on plan and shall be fastened to the web of the rail by bolts or rivets not less than ¾-in. in diameter.

Bolts.—Bolts must be round and true to size, with square heads and nuts. Threads must be accurately cut and nuts must have a wrench-tight fit. Each bolt must be provided with an approved head lock and a nut lock of approved pattern large enough to give full bearing for the nut. A ¼-in. cotter pin shall, when required, be placed outside of and close up to the nut after it is tightened. Beveled washers must be used wherever necessary to give the head and nut a full, square bearing. Separate head lock shall be of material not less than $\frac{3}{16}$-in. thick. Washers used under heads may be of such design as to act as head locks. Bolts must be long enough to allow the nuts to be brought out from under the head of the rail, with a suitable washer not less than ½-in. thick, so that the nuts may be readily tightened with an ordinary wrench.

Rivets.—The diameters of the rivets shall be of full size shown on plan, and the diameters of the rivet holes shall be not more than $\frac{1}{16}$-in. greater than the diameters of the corresponding rivets. The rivets shall be of sufficient length to provide full, neatly made heads when driven. They shall be driven tight, bringing all adjacent parts into contact.

Rivets, when not countersunk or flattened, shall have standard button heads of uniform size for the same size rivets. The heads shall be full and neatly made and concentric with the holes. When the rivet heads are countersunk they shall be flush with the plate and fill the holes.

Reinforcing Bars.—Reinforcing bars shall fit the fishing angles and web of rail throughout their length.

Plates.—Plates shall be flat and true to surface.

Springs.—Springs shall have the ends square with the axis, so that when the spring is placed on end on a flat surface it will stand perpendicular thereto.

Spring Covers.—Spring covers shall be of such dimension as to permit a proper working of the springs and shall be provided with a spring bearing for each end of the spring.

Braces.—Braces shall fit the head and web of rail accurately.

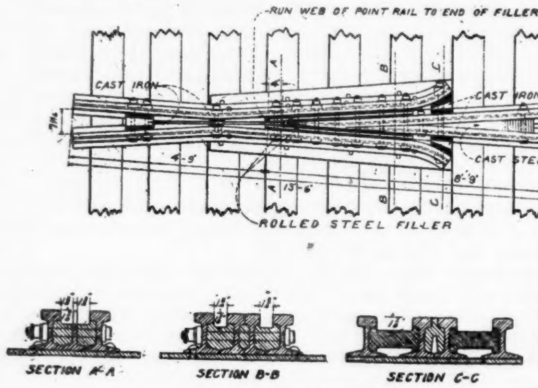
Stops and Hold-downs.—Stops shall be so placed on plates as to hold the wing rail at 1⅞-in. opening at the ½-in. point. Hold-downs shall fit stops so as to allow at least 2-in. horizontal play and not more than ⅛-in. vertical play.

Anti-creeping Device.—The anti-creeping device shall fit accurately to the parts of the frog or angle bars.

Holes for Main Bolts.—Holes shall be drilled from the solid. No punching will be permitted except of bottom plates and washers. Drilling shall be accurately done, on bevel where necessary, and holes shall be made $\frac{1}{16}$-in. less in diameter than the bolt to be used. Then the parts shall be assembled and the holes reamed so they are straight and true, with no offsets between the adjacent parts and of such size as to give the bolts a driving fit for their entire length.

In lieu of the above specification for drilling and reaming, the manufacturer may assemble and accurately fit all the parts, before any drilling whatever is done; after the parts are securely clamped in their correct positions the holes may be drilled of such a size as to give the bolts a driving fit for their entire length.

Marking.—The number of the frog, maker's name, weight of rail and the date shall be plainly stamped with ¾-in. figures and letters on the flare of one wing rail for rigid



WEIGHT OF RAIL	SIZE OF FROG BOLTS
100	[illegible]
90	[illegible]
80	[illegible]
70	1"
60	[illegible]

No. Eight Rigid Frog.

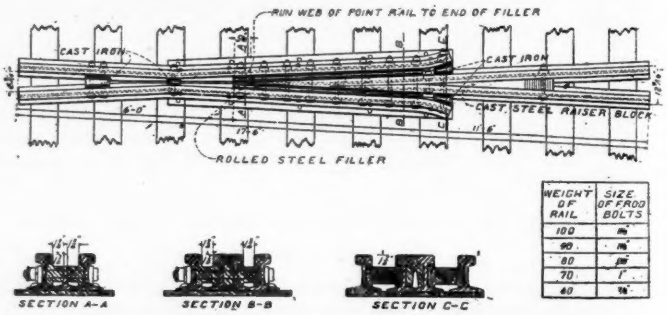
frogs and the flare of both wing rails for spring frogs, or a plate shall be fastened to the frog with the same information.

Switches.

Throw.—5 in. at center line of No. 1 rod.

Gage of Track.—4 ft. 8½ in.

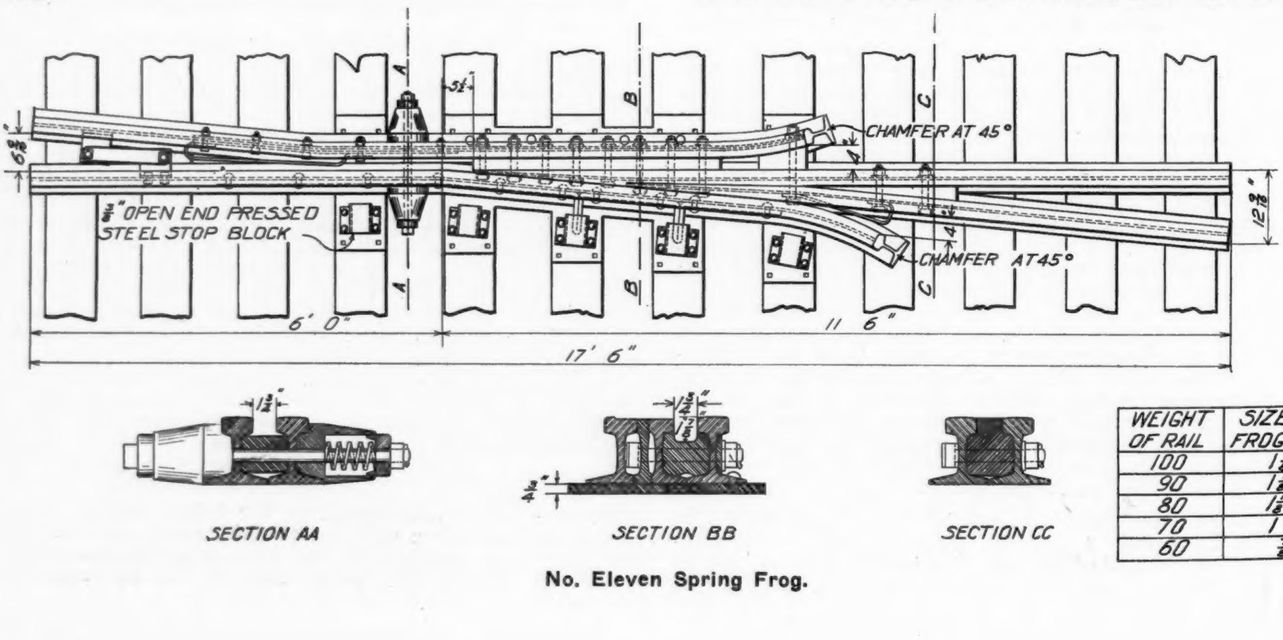
Switch Rails.—Side planing and bending shall conform to a spread at the heel of 6¼ in. between the gage lines of the stock rail and the switch rail and a thickness of



WEIGHT OF RAIL	SIZE OF FROG BOLTS
100	[illegible]
90	[illegible]
80	[illegible]
70	1"
60	[illegible]

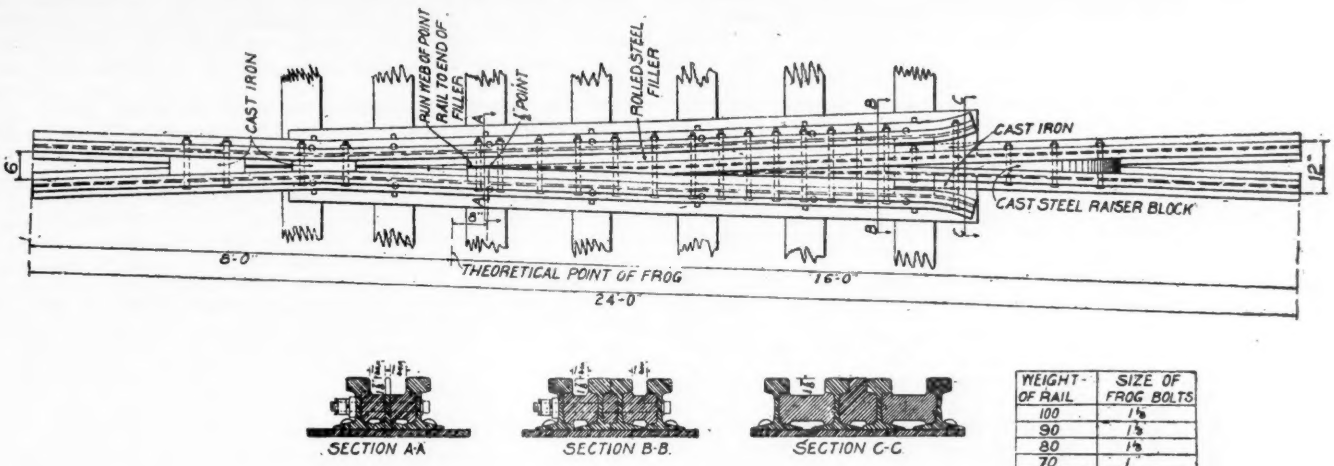
No. Eleven Rigid Frog.

¼ in. at the point. The bending and planing shall be done so as to give a straight gage line to the switch rail. The switch rail shall afterward be ground down to a thickness of ⅛ in. at the point, beginning 2 ft. back from the point of the switch; the point of the switch shall then be ground



WEIGHT OF RAIL	SIZE OF FROG BOLTS
100	1⅛"
90	1⅛"
80	1⅛"
70	1"
60	⅞"

No. Eleven Spring Frog.



WEIGHT OF RAIL	SIZE OF FROG BOLTS
100	1⅛
90	1⅛
80	1⅛
70	1"
60	⅞

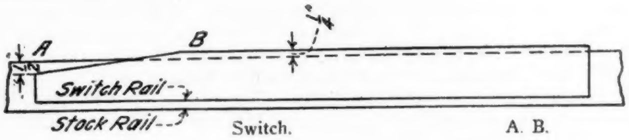
No. Sixteen Rigid Frog.

down to a sharp edge with a radius of 1½ in. The head of switch rail shall fit neatly against the head of stock rail from point of switch rail to point of divergence. The inner edge of the head of the stock rail and the outer face of the web of the switch rail at the point shall be in the same vertical line when the switch rail is fitted against the stock rail.

Top planing shall conform to the measurements shown in the accompanying figure and table.

Bottom of switch rail shall be planed to fit neatly on base of stock rail where bases overlap.

The point of switch rail shall be as shown in the detail drawing herewith.



Switch.	A. B.
33 ft.	12 ft.
22 ft.	9 ft.
16 ft. 6 in.	5 ft.
11 ft.	5 ft.

Planning of Switch Point and Stock Rail.

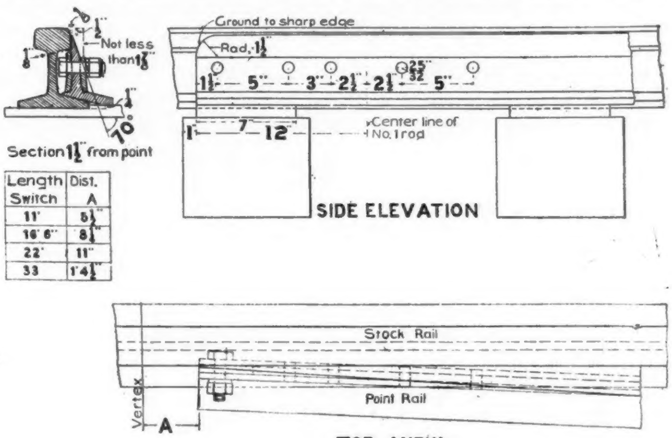
Holes for switch rod lugs and stop blocks shall be $\frac{25}{32}$ in. in diameter and 5 in. center to center. Holes for reinforcing bars shall be $\frac{25}{32}$-in. diameter. Number and location as provided under "reinforcing bars."

Lugs.—Lugs shall be as deep as the section of rail will permit.

Distance between centers of holes for bolts running through the web of the rail shall be 5 in. Diameter of holes shall be $\frac{25}{32}$ in. Switch rod bolt hole shall be $1\frac{1}{32}$ in. in diameter.

Switch Rods.—Switch rods shall be ¾ in. by 2½ in. and shall be held in a horizontal plane. Bolt holes shall be $1\frac{1}{32}$ in. in diameter. There shall be at least 1½ in. of metal at end beyond bolt holes.

Reinforcing Bars.—A reinforcing bar ⅜-in. thick shall be riveted to each side of each switch rail and point ends shall be made flush with point of switch rail. The bars shall be as long as the heel connections will permit. Bars shall fit against web of rail and shall fill the space between

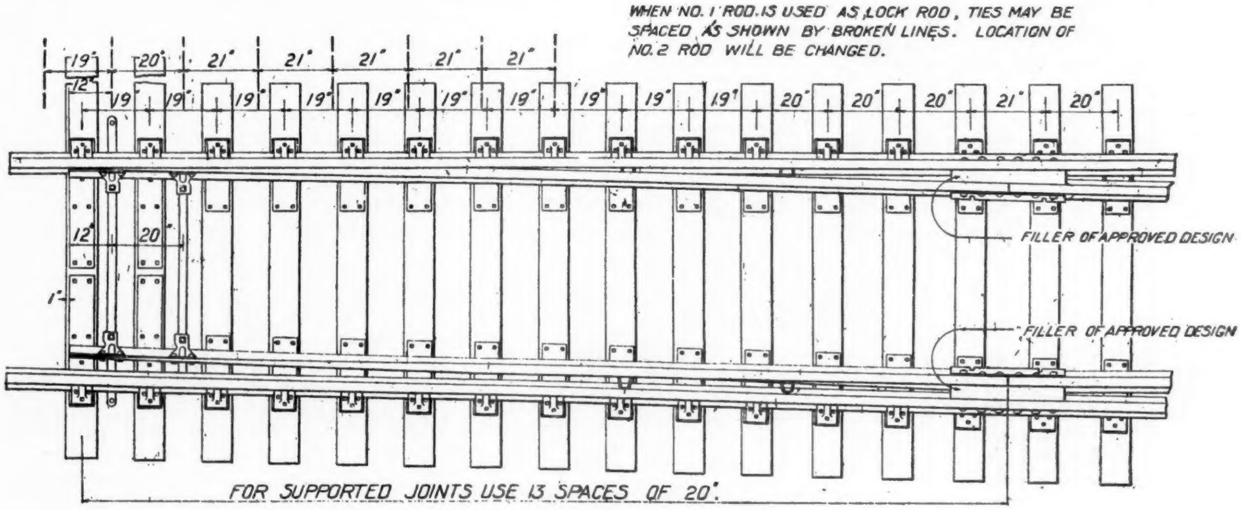


Length Switch	Dist. A
11'	5½"
16' 6"	8¼"
22'	11"
33	1' 4½"

Details of Point.

head and flange of rail. There shall be ½-in. clearance between outer bar and head of stock rail where the bar projects under the head of stock rail. Top of inner bar, where it projects beyond the head of switch rail, shall not be less than 1⅞ in. below the top of stock rail. The reinforcing bar shall be beveled to an angle of 45 deg., where it projects beyond the head of the rail.

Bars shall be fastened to rail with ¾-in. (insert "rivets"



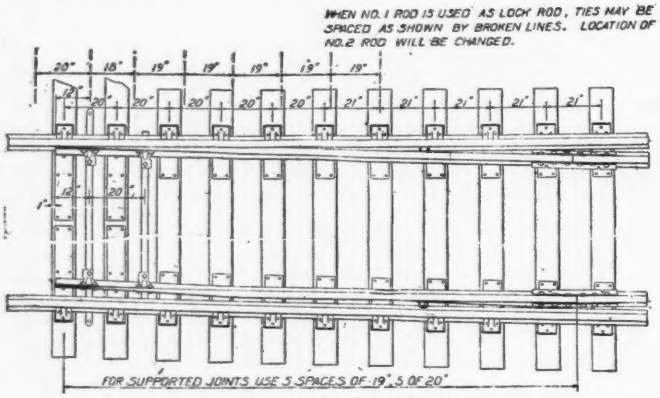
Twenty-Two Foot Switch.

or "bolts"), except that at the first, second and fifth holes, and the holes through which the lugs are fastened, they shall be bolted. Center of first hole shall be 1½ in. from point and center of last hole in bar shall be 2 in. from heel end of bar. Intermediate (insert "rivets" or "bolts") shall be spaced so that there shall be fastenings at intervals not greater than 12 in.

Stop Blocks.—Stop blocks shall be of approved design with holes 13/16 in. in diameter. Stop blocks shall be spaced as nearly as practicable at equal intervals between the end of planing and heel of switch.

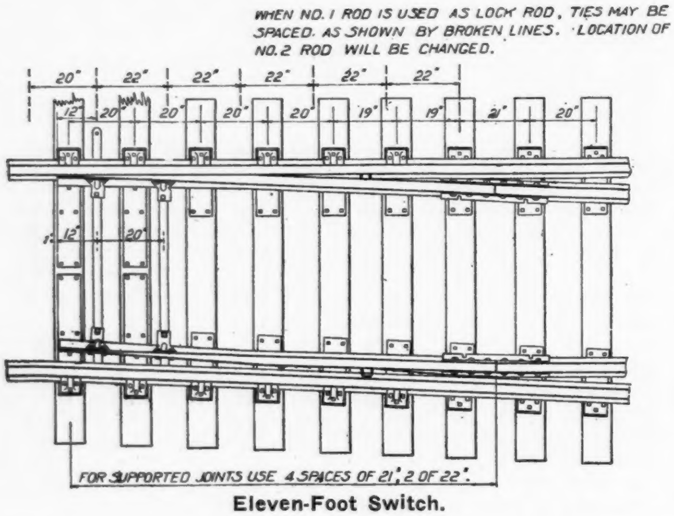
Heel Blocks.—Heel blocks shall be of approved design with standard rail drilling.

Bolts and Nuts.—Bolts fastening lugs, stop blocks and foot guards to switch rails shall be ¾ in. in diameter.



Sixteen-Foot Six-Inch Switch.

Bolts connecting the lugs with switch rods and the switch-stand connecting bolt shall be 1 in. in diameter and machine turned. All bolts shall be provided with nut locks



Eleven-Foot Switch.

and cotters. ¾-in. bolts shall have hexagonal nuts and 1-in. bolts shall have square nuts.

Rivets.—The diameters of the rivets shall be of full size shown on plan, and the diameters of the rivet holes shall not be more than 1/16 in. greater than the diameters of the corresponding rivets. The rivets shall be of sufficient length to provide full, neatly made heads when driven. They shall be driven tight, bringing all adjacent parts into contact.

Rivets, when not countersunk or flattened, shall have standard button heads of uniform size for the same size rivets. The heads shall be full and neatly made and concentric with the holes.

When the rivet heads are countersunk they shall be flush with the plate and fill the holes.

Plates.—There shall be on each tie two plates of suitable length ⅞ in. by 1 in., planed down to receive the stock rail and braces. Three holes outside and two inside are required for ⅞ in. lag screws or screw spikes, or for ordinary spikes, as may be specified, on all switch ties, except the two head ties, where there shall be three outside and five inside, one of the inside holes to be in position for spiking the switch.

Braces.—Braces shall be of such a design that 2½-in. clearance for detector bars may be obtained. Three holes for ⅞-in. lag screws or screw spikes shall be provided.

Foot Guards.—Strap foot guards shall have a minimum thickness of ⅜ in. and shall be fastened to the web of the rail by ¾-in. bolts or rivets.

Note.—The following members of the committee approve the report as submitted herewith: J. B. Jenkins, Chairman; L. S. Rose, Garrett Davis, J. R. Leighty, Curtiss Millard, T. H. Hickey, Raffe Emerson, J. M. R. Fairbairn, H. T. Porter, P. C. Newbegin, W. G. Raymond, S. S. Roberts, F. A. Smith, R. A. Van Houten, W. J. Towne, H. R. Safford, R. H. Pearce, C. H. Stein, Thos Maney.

The following members approve the report conditionally: G. J. Ray, A. Bruner, F. S. Stevens.

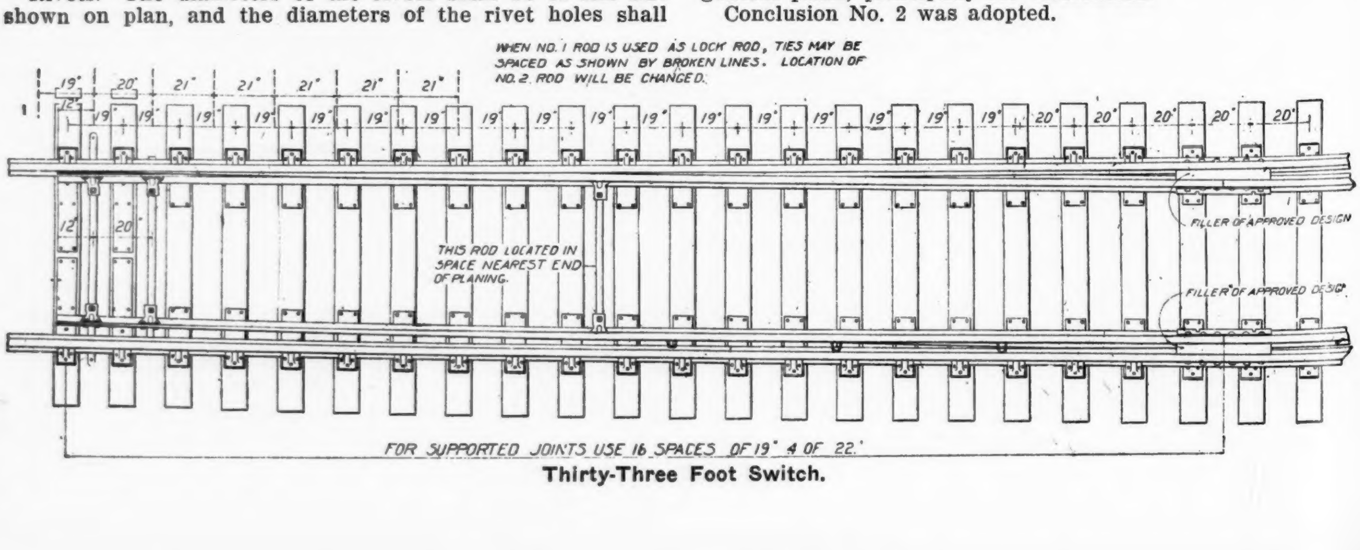
The following members dissent from portions of the report: Geo. H. Bremner, R. O. Rote.

Discussion on Track.

Mr. Jenkins: We originally had our specifications and plans for frogs and switches together and there has been some objection on the part of some members of the association on account of the plans being in too great detail, and on the part of others because they are not in sufficient detail. Part of the association considered that the plans should not be a part of the specifications, another part, apparently, that thought the specifications should be accompanied by complete and detailed plans. The committee, at the last convention, submitted plans for these frogs and switches, which we have gone over carefully and revised, and we also revised and combined the general specifications for frogs, crossings and switches, which were adopted in 1910, with the general instructions for contracting frogs, crossings and switches which was submitted in 1911, and received only as information. We have not only combined them but revised them, and we wish to submit them for adoption. We wish to submit the specifications without the plans and submit the plans separately.

At the request of the president the committee will ask action on conclusion No. 2, that the plans of No. 8, No. 11 and No. 16 rigid frogs, No. 11 spring frogs, and 11-ft., 16½-ft., 30-ft., and 32-foot switches be adopted as general plans representing good practice, and published in the manual. The adoption of this plan has no bearing on No. 3, which recommends these lengths of switches. The adoption of conclusion 2 only carries with it the recommendation of these plans for these numbers. The plans, it may be stated, are general plans, principally for dimensions.

Conclusion No. 2 was adopted.



Thirty-Three Foot Switch.

Mr. Campbell: Referring to the plans for the 33-ft. switch, I would like to ask if the committee came to any conclusion in relation to the joints in the main line rails. As far as I see this plan does not show the location of any of the joints. Also, has the committee considered special rail lengths for these turnouts? How does the committee propose to handle turnouts in case the proper length does not make up commercial lengths of rails? Where would we put the joints in the main line for this switch?

Mr. Jenkins: The committee has considered both questions raised in regard to the joints for the 33-ft. switch. We considered the best practice would be to use a 30-ft. stock rail. The plans for the switches are general. In the specifications we say, "Heel blocks shall be of approved design, with standard rail drilling." On the plan itself it says: "Filler of approved design." We could not indicate more than one heel block on the plan, so we only indicated one.

Mr. Lindsay: On the drawing of the switch point the first pair of holes, 5 in. apart, are 1½ in. from the point. That, I believe, is done at the behest of some of our friends who desire to put on the modern type front rod for the lagging apparatus at interlocking plants, and that requires alternate spacing of ties on the plans of switches required. If it is safe to allow the switch point to project, as it will for the use of the head rod of that type in those holes, to jroject over a foot from the first rod, it would be better, it seems to me, to adopt the alternate spacing of ties shown here, rather than the primal one, because it would be safe to fasten a head rod to these first two holes and at or between the ties. I do not consider the alternate spacing of the ties shown on the plans as necessary in any way whatever.

Mr. Jenkins: We do not think that all roads would want the first spacing of ties shown, and some of them would prefer the alternate spacing and we have put on both of them for that reason. If any road desires to use the first spacing altogether and considers that the best practice, there is no reason why they should not follow that throughout.

A vote on the motion to adopt the second conclusion showed: affirmative, 23; negative, 13.

Mr. Jenkins: The committee was asked by the Board of Direction to recommend three frogs and three lengths of switches. We thought it necessary to include the fourth length of switch for industrial sidings, and short turnouts, where such turnouts are required. In recommending these three lengths of switches, with one additional length, we took the 33-ft. rail and cut that economically so as to make the lengths 33, 22, 16½ and 11. Our principal reason for doing this is that for the longest turnout we want the very best rail, and we can probably get the best rail by using a 33-ft. rail. We will probably also want to specify that this rail shall come from a certain part of the ingot. As to the frogs, we are perfectly aware that there are very few No. 11 frogs in use at the present time; that more roads use No. 10 than any other number of frog, but if we adopt a No. 8 for yards and No. 10 for main line turnouts, that only leaves us one other turnout to use for the low and the highest restricted speed. While the No. 11, with the 22-ft. switch point, will answer for the low speed controlled by interlocking, just about as well as the No. 12, the No. 16 will answer fairly well for the highest restricted speed, because the deflection of an engine through the lead of No. 16 is about the same as that through the 33-ft. switch point, so the No. 11, if we are confined to three numbers, will answer the purpose of the present No. 10 and No. 12. The No. 16 will answer the purpose of the 14, 15, 16, 18 and possibly the 20. I think the present practice for yard turnouts is tending very strongly towards No. 8, so that our recommendation in that regard is not at variance with practice. Another reason for the No. 11 is that if we adopt a standard for general use, we want to take that number of frog which will give the most economical use of the rails, and if you will refer to the table of practical leads in the manual, you will find that No. 11 is the best suited to that purpose.

Our committee would like definite action on this, either adoption or rejection, with further instructions, because our study of main line turnouts depends on your action on this. If the association thinks that three numbers of frogs are not sufficient, we can very readily take up a recommendation for a greater number; but the committee itself feels that these three frogs are sufficient, and of course every railway which uses No. 10 would not want to tear out all the No. 10 and put in No. 11. But I do not think there is any necessity for doing so. When new work is laid out it can be done with No. 11, and eventually the railways will come to these three standards, which will be economical. I move the adoption of conclusion 3, and that the recommendation be published in the manual.

G. W. Kittredge (N. Y. C. & H. R.): I am not altogether satisfied with the reasons given why we should go from No. 10 to No. 11. I know a great many roads that use No. 10 quite generally, and it was only a few years ago that a No. 10 frog was considered one of the maximum numbers to be used in any location.

Mr. Morse: On our road we adopted 8, 10 and 14. I think 8, 11 and 16 are all right. In regard to Mr. Fritch's proposition to add to that a new frog, I don't believe any road that has adopted a set of standards is going to change them to go with this, but there are a good many roads I presume, that are about up to the point where they have got to change their standards, the same as we were a few years ago when we were using 6½ and 9. We finally adopted 8, 10 and 14. I favor the recommendation.

Mr. Fritch: I suggest that conclusion 3 be subdivided into two parts, one governing recommendation in regard to length of switches, and one in regard to number of frogs. It is possible that some of them can agree on the number of frogs, who would not agree on the switches, and vice versa.

The President: There is no objection to that; so the motion will be revised to include frogs only.

The President: We will wait until we come to that part.

Mr. Kittredge: We have, as I understand, already adopted the plans for No. 8, 11 and 16 frogs. It might be a little inconsistent if we vote any other way than to follow the motion of the chairman, to adopt the frog, the plans for which we have already accepted.

The President: We are not adopting the numbers in adopting the plan.

Mr. Jenkins: The No. 11 frog, with 22 switch point, takes 33-ft. rails for the lead curve, one of which is cut to 32.85, 1⅞ inches cut off of one of the four rails.

Motion carried.

Mr. Jenkins: I move that the committee's recommendation in regard to lengths of switches be adopted, with the recommendations published in the manual.

Motion carried.

Mr. Fritch: I move to amend the recommendation by specifying the switches 11 ft., 16½ and 26 ft.

Mr. Jenkins: It is the opinion of the committee that 26½ ft. does not give quite a small enough angle for the highest restricted speed for junctions; that we should use as long a switch point as possible, and that in addition we want to use the full length of rail in order to have every possible assurance of getting the best rail for that switch point.

Mr. Porter: Several years ago, when the matter was brought before the committee, they came to the conclusion that for high speed crossovers and turnouts, it was desirable to have as long a switch point as practicable, under the conditions that we were working with. After conferring with the rail makers of this country, we found that 93 or 94 per cent of the rail which they sent out was to a standard of 33-ft. lengths. If you accept the 33-ft. rail, then you can specify just the part of the ingot it comes from. The rails being rolled now are marked A. B. C, D, depending on whether they are rolled from the top of the ingot, the middle rail of the ingot, or the bottom of the ingot. So we can put it in the power of the engineers to specify where that rail shall come from, and they can do that with the 33-ft. length switch, or with switches made out of 33-ft. length rails. Five per cent of the rails are of shorter lengths, dropping down according to the various specifications, either a foot at a time or two feet at a time, so if you have a 26-ft. switch the chances are you will get it out of a shorter rail. Another object in having the longest rail we could get was to make the curve in the lead as light as possible. In France tey are using now, at junctions, a rail 39-ft. and some inches long, and they are using them successfully and are maintaining a speed through the switches, even on the branch lines, of 62 miles an hour without a shock. That seems to be the tendency in France, and I believe in some of the other European countries they are making experiments in the same direction. So we feel that we ought to at least go as far as 33 ft. in order to get as light a curve as possible.

After adopting the switch point that gave us the lightest curve in the lead, it was figured out by one of the members of the committee that a No. 16 frog gives the curve that produces the least deflection as an engine passes through that point. So for the purpose of getting the best rail, the lightest curve, and a point that would give the same deflection through the curve as a No. 16 frog, we feel that we ought to use a 33-ft. point.

The President: The remaining subjects will be discussed at the opening of the session Wednesday morning.

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PRESENT MEMBERSHIP OF THE A. R. E. A.

The secretary's report, presented yesterday, showed the following membership figures:

Membership March 15, 1911		967
Additions during the year		95
		1,062
Deceased	7	
Withdrawals during the year	13	
Dropped for non-payment of dues	12	
	32	32
Total membership, March 15, 1912		1,030
Net increase		63

There are now 939 members, 4 honorary members and 87 associates.

Geographical Distribution.

The geographical distribution of the membership is indicated in the following table:

United States	899	Korea	1
Dominion of Canada	83	Panama	1
Mexico	9	Australia	1
Cuba	5	Great Britain	1
China	6	Peru	2
New Zealand	4	Russia	1
Philippine Islands	3	Central America	2
India	2	Porto Rico	1
Bolivia	1		
Japan	8		1,030

Classification of Members.

Presidents	22
Assistants to president	2
Vice-presidents	27
General managers	20
Director maintenance and operation	1
Assistant general managers	8
General superintendents	16
Assistant general superintendent	1
Division superintendents	38
Chief engineers	121
Assistant chief engineers	16
Principal assistant engineers	14

Chief engineers maintenance of way	6
Assistant chief engineers maintenance of way	5
Engineers of construction	14
Engineers maintenance of way	86
Bridge engineers	27
Engineer surveys	1
Division engineers	86
Assistant engineers	111
District engineers	13
Electrical engineers	2
Inspecting engineers	14
Supervising engineer	1
Architects	4
Locating engineers	3
Engineers track economics	1
Engineers track and roadway	4
Maintenance of way accountant	1
Engineers bridges and buildings	7
Office engineers	5
Chief draftsmen	4
General roadmasters	2
Roadmasters	16
Master carpenters	2
Rail expert	1
Superintendents bridges and buildings	9
Supervisors	2
Resident engineers	36
Signal engineers	18
Assistant signal engineer	1
Managers timber department	6
Chief timber inspector	1
Foresters	3
General foreman water works	1
Supervisor materials	1
Chemists' and engineers' tests	4
Metallurgical engineers	4
Professors in colleges	19
Associate professors	16
Civil engineers	50
Consulting engineers	89
Contracting engineers	13
Engineers grade elimination	4
Purchasing agent	1
Receivers	3
Editors	3
Inspectors maintenance	3
Masonry engineer	1
Assistant superintendents	2
Engineers valuation	2
Drainage engineer	1
General agent	1
Engineer water service	1
Municipal engineers	6
Commercial engineer	1
Miscellaneous	5
Total	1,030

THE USE OF DYNAMITE IN TRACK DRAINAGE.

When giving consideration to the best ways and means for improving track drainage, certain new methods of draining and ditching with dynamite which have been successfully applied lately in land reclaiming operations are of interest. In this work, two comparatively new principles are applied.

By taking advantage of the fact that water and wet ground are excellent conductors of the detonating wave, ditches may be dug with dynamite at a low cost and with a minimum of labor when conditions are favorable, because it is necessary to prime only one charge, no matter how long a ditch may be blasted.

When draining swamps, ponds and other low ground by the dynamite method, the impervious subsoil which is responsible for holding the surface water is so shattered and broken by blasting it in a few places that surface water will sink into the earth and flow away along natural underground drainage channels.

Ditches can be blasted through comparatively open and dry soils, but here it is sometimes necessary to prime each charge and accordingly increase the expense somewhat, though this is offset to a certain extent by spacing the charges farther apart.

The cheapest ditches may be blasted through wet clay when water covers the surface or rises almost to the surface in the holes which are punched for the charges of dynamite. Here only the middle charge of the long line is primed, but little labor is required to punch the holes and no tamping of the charges is necessary, as the water serves this purpose. One row of charges is sufficient to blast a ditch 5 to 7 ft. wide, while two parallel rows are necessary for ditches 8 to 14 ft. wide and three rows for those from 16 to 20 ft. wide. The rows are spaced from 2 to 4 ft. apart and the holes in each row from 18 in. to 2 ft. apart. Sometimes the holes are vertical, but generally they are put down at an angle of 45 deg. to 60 deg. to the horizontal, all pointed toward the side of the ditch on which the material excavated is to be thrown and all put down to a depth about 6 in. less than the grade of the finished ditch. The material thrown out is not heaped up along the side of the ditch, but is spread by the blast evenly over the ground for some distance.

The charge in each hole is usually one 1¼ in. x 8 in. cartridge, weighing a half pound, of 50 or 60 per cent nitroglycerin dynamite. Old-fashioned nitroglycerin dynamite is said to be the only kind that can be depended on to transmit the detonating wave properly from charge to charge, as it is more sensitive than the modern brands having low freezing properties and other advantages. This makes it necessary to blast ditches only at those seasons when the earth, water and air are at temperatures higher than 45 deg. or 50 deg. F.

The middle hole of the row is charged last, a double quantity of dynamite being used in this charge, so that the initial detonation will be heavy. This is the only charge primed, and a No. 6 blasting cap and piece of waterproof fuse are used for this purpose. The effect of the explosion of this charge is transmitted to the adjoining charges in both directions and thus relayed almost instantaneously to the opposite ends of the ditch, the result being a perfectly formed ditch with all of the material cleaned out and spread over the adjoining land some distance away. If there is more than one row of holes, it is only necessary to prime the middle charge in one of the rows, but if the rows are spaced more than 2 ft. apart it is best to charge an extra hole between the primed charge and the nearest charge in the other rows.

In reclaiming land, ditches 20 ft. wide at the top and 5 ft. deep are said to have been dug with dynamite at a total cost of less than 10 cents per cu. yd. This includes all labor and explosive charges and is for a satisfactorily shaped-up and cleaned-out ditch. Smaller ditches from 3 to 4 ft. deep, 3 ft. wide at the bottom and from 5 to 7 ft. wide at the top usually cost about 2 cents to 4 cents per lineal foot. Among the great advantages of digging ditches with dynamite are low cost, minimum time and labor, no previous clearing necessary even when ditching through land covered with thickets, brush, trees, stumps or fallen timber.

Swamps and ponds are often drained permanently by fracturing and shattering with dynamite the impervious substratum under them. In this work, test or proving holes are first put down to determine the thickness of the clay stratum and what is under it. If the clay is thoroughly broken through in three or four of the lowest places and a little ditching done, many acres can often be permanently drained, the water all settling into the deeper strata through the

blasted sections. These places once properly opened, rarely close up again, the water flowing through them having more of a tendency to keep them open.

To blast these drainage openings, the charge of explosives should be located several feet above the bottom of the clay stratum if sand, gravel or other open material is under it. If the clay stratum is directly underlaid by rock, the holes should be bored down onto this rock, so that the explosion of the dynamite may open fissures between the clay and the rock or through the rock itself. The boring and charging of these holes is often done from roughly constructed rafts, a popular tool for the purpose being a Pugh blasting auger with rod or pipe extension. Gelatin dynamite, of the 40 per cent grade, in cartridges 1¼ in. x 8 in., is the explosive said to be best suited for this work, and the quantity required for each charge is naturally governed by the thickness and nature of the clay stratum. As a general rule, about seven of these cartridges, which weigh a little more than a half pound each, may be considered the approximate charge when the clay stratum is from 7 to 10 ft. thick. If it is 20 ft. thick, seventeen cartridges should be used, if 30 ft., twenty-five cartridges, and if 40 ft., thirty-five cartridges. The charges are always exploded electrically in this blasting, and specially waterproofed electric fuses should be used.

RELATIVE COSTS OF MAINTAINING ANCHORED AND UNANCHORED TRACK.

It is of interest to compare the cost of maintaining track which is anchored against creeping with similar track which is unanchored, whenever it is possible to secure accurate records showing these differences. An instance in which such records had been kept was recently found. In this case, fortunately, part of the stretch of track was anchored and part not anchored on the same line of railway and the several portions were adjacent to each other, thus insuring the same condition of traffic and roadbed.

The observations were made on three and one-half miles of double-tangent track running north and south, with practically no grade, light gravel ballast, 85-lb. rail and broken joints. The heavy traffic was northbound; consequently, all data are based on the northbound track, as the creeping tendency here was decided. This track had been put in service 14 months before, and one mile in the center of the stretch was anchored, leaving one and one-half miles on the north and one mile on the south end not anchored. Where the track was anchored, 640 anti-creepers were applied, two per rail length, opposite joints against opposite end of joint ties. The anti-creepers have received no maintenance and have shown no failure, although they had been in service 14 months at the time of inspection.

The character of the work done on the two pieces of track in 14 months is stated in the parallel columns below:

ANCHORED TRACK.	UNANCHORED TRACK.
Track resurfaced once.	Track resurfaced twice.
	Ties spaced twice.
	Rail driven back twice.

The total maintenance cost for the mile where the anti-creepers were applied, including the cost of anti-creepers, is as follows:

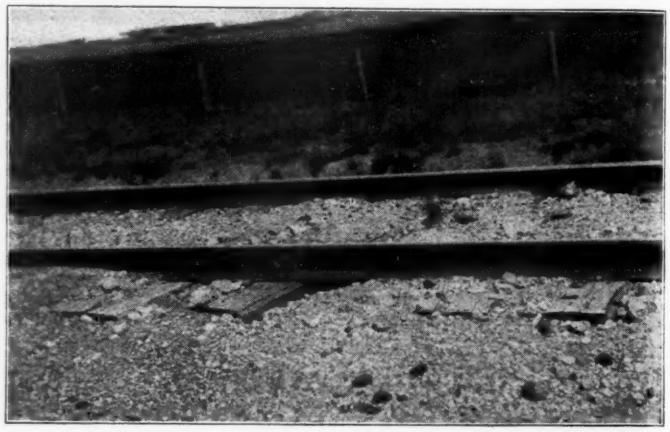
Cost of anti-creepers, 640 at 17½c each	$112.00	
Applying 640 anti-creepers at ½c each	3.20	
Resurfacing, 10 men working 16 days, at $1.55 per day	248.00	$363.20

The total cost of the next mile north of the mile where the anti-creepers were applied, subject to the same conditions of traffic, roadbed, etc., but unanchored, is given below:

Cost of resurfacing twice, each time 10 men, 16 days, at $1.55 per day, $248	$496.00	
Cost of respacing ties twice, each time 10 men, 17 days, at $1.55 per day, $263.50	527.00	
Cost of driving back rail twice, each time 10 men, 2 foremen, 6 days, at $1.55 per day, $111.60	223.20	$1,246.20

Showing a net saving in 14 months' time for one mile of track in favor of the anchored track of $883.

It will be noted that the original cost of the anti-creepers and of their application have been included in the first 14 months. These costs are properly chargeable over the total number of years anchors are in service, which in all cases is at least as long as the life of the rail on which they are applied. This would make the saving considerably greater than has been estimated. Furthermore, this maintenance cost does not include injury done to ties, spikes and joints, which was considerable where anchors were not applied, as the creeping had pulled the ties badly askew, bending or

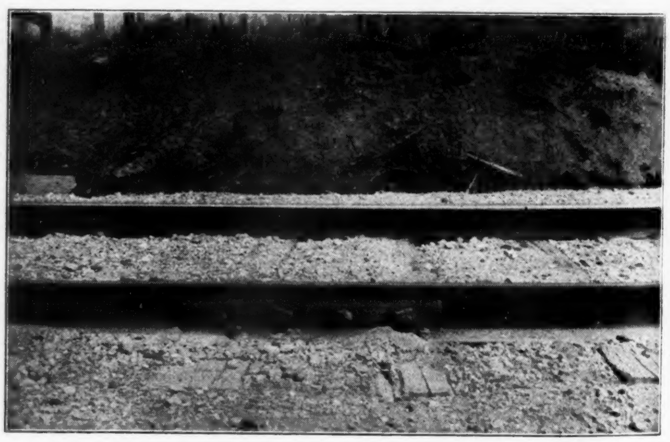


Condition of Unanchored Track Seven Months After Ties Were Spaced.

completely destroying the spikes and often causing broken joints. Where the anti-creepers were applied, this wear and tear were hardly worth considering.

The above figures were obtained directly from the railway, and the roadmaster stated that he could have maintained this 3½ miles of track in better shape with three men less per year had he been allowed to anchor the balance.

This illustration is taken from a point where creeping has been severe, but cases are not infrequently cited where the use of 500 anchors to hold a crossing at an expense of



Condition of Anchored Track at End of Fourteen Months, During Which Track Had Not Been Touched.

$87.50 for the anchors, has held the crossing so that where formerly it was driven back every six weeks, after it was anchored, the crossing had not been touched for ten months, thereby saving the cost of the anchors in that short length of time because the crossing did not have to be driven back.

Most roads have some points of severe creeping, and it is now generally recognized that all double track creeps. Each year makes it more and more apparent that a double track road is not completely equipped as regards its track until it has anchored it against creeping. This not only prevents the rail moving, bending and kinking, but also allows the ties to remain on their original tamping, thereby holding the track in better surface.

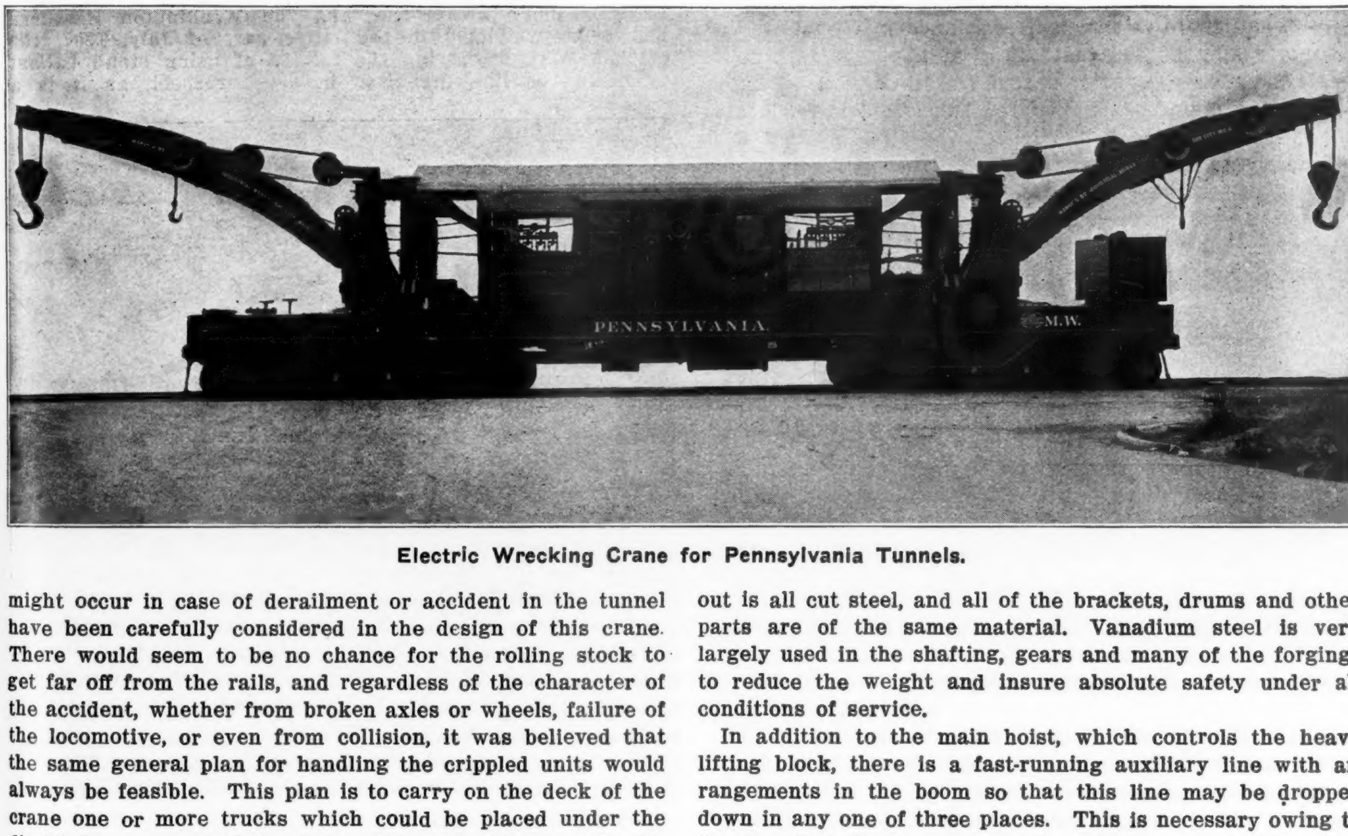
ELECTRIC WRECKING CRANE FOR PENNSYLVANIA TUNNELS.

The construction of the tunnels of the Pennsylvania Railroad under the East and North rivers at New York City has been followed with great interest, but the equipment of these tunnels has been an important matter and has involved radical departures from current practice. Among the new equipment installed is an electrically-operated wrecking crane. The peculiar requirements of the Pennsylvania terminals call for a crane to be electrically operated under all conditions, whether the third-rail is in service or not; and also to be able to operate with equal efficiency at either end. Practically no overhead room is available above the top of the rolling stock, and the right of way is confined so closely by the side walls that there is practically no room at the side of the tracks to work. It became evident early in the design of a crane to meet these requirements that the capacities desired and the manner of operation would call for a very heavy crane. It was therefore necessary to use the highest grade of materials throughout, lighten the construction thereby as far as possible and distribute the weight over as many wheels as consistent, arranged in trucks giving a long-wheel base.

While wrecks are never made to order, and hardly any two call for the same equipment, the possibilities of what might occur in case of derailment or accident in the tunnel have been carefully considered in the design of this crane. There would seem to be no chance for the rolling stock to get far off from the rails, and regardless of the character of the accident, whether from broken axles or wheels, failure of the locomotive, or even from collision, it was believed that the same general plan for handling the crippled units would always be feasible. This plan is to carry on the deck of the crane one or more trucks which could be placed under the disabled car so as to bring it in safety out of the tunnel. To accomplish this, it would be necessary to raise up one end of the car or locomotive and, while holding it suspended with the main hoist mechanism, lower the spare truck on to the tracks by means of the auxiliary hoist and roll it in place, if this is possible. After this is done the plan would be for the crane to propel itself with whatever suspended loads were necessary and drag the broken cars or locomotive out of the tunnel to the terminal.

In practically every wreck it would be necessary to disconnect the third-rail at a point perhaps 500 to 1,000 feet away and provision is made in this wrecking crane to connect with the third-rail at this point, and thus be supplied with power as described later on.

The requirements outlined above were successfully met in the design and construction of the crane shown in the accompanying cut. The car is exceptionally heavy, approximately 61 ft. long, mounted on two sets of articulated trucks, so that each end of the car is mounted on 8 wheels, all properly equalized. The two ends of the car are duplicates, and at each end is mounted a curved boom made of structural material and of the same general shape as is used in standard wrecking cranes. This boom, however, is mounted on a structural steel "A" frame and mast, with roller and ball bearings of unusual size and design, and with manganese and vanadium steel bearing plates. These booms will swing to 90 deg. either side of the center, as described later on. The car body is supplied with swinging outriggers or jack arms, which can be readily hauled up out of the way. These arms cannot be used in the tunnel while the crane is at work, as the full capacity must be reached without their use. They are provided, however, for such further use as may be found for the crane in construction work and ordinary yard service. Machinery is all massed in the center of the car body and mounted in cast steel housings. The gearing for the various motions is practically duplicated for the two cranes described above, although contained in the same frames and performing the same functions for each crane. One motor of 250 h. p. is so connected to these trains of gearing that either end may be operated independently from the other end, or both may be operated together. The gearing throughout is all cut steel, and all of the brackets, drums and other parts are of the same material. Vanadium steel is very largely used in the shafting, gears and many of the forgings to reduce the weight and insure absolute safety under all conditions of service.



Electric Wrecking Crane for Pennsylvania Tunnels.

In addition to the main hoist, which controls the heavy lifting block, there is a fast-running auxiliary line with arrangements in the boom so that this line may be dropped down in any one of three places. This is necessary owing to the fact that the boom cannot be raised to any height when in the tunnel. Winch heads are also provided on both sides of the frames, operating independently of the two drums, and with arrangements on the booms so that the lines may be run down at any one of four points. With these three methods of hoisting, a great variety of operations can be effected, as the clutches are so arranged as to make each motion independent of the others. Swinging the booms with their suspended loads is effected by means of a train of cut steel spur and bevel gearing, thrown in operation by means of double friction clutches. The arrangement is such that swinging may be done in either direction regardless of the direction of the rotation of the motor.

The propelling feature of the crane is an extremely important one, as the crane must handle itself under full load

in the tunnel and, if necessary, move out into the terminal with loads suspended from it. The capacity requirements of the propelling feature are that it shall be able to travel at a rate of three miles per hour up a 2 per cent grade with 65 tons hanging suspended from the boom, and pulling in addition to this a load of 83 tons. This specification would enable the crane to take out successfully a crippled locomotive unit or any piece of rolling stock. To accomplish this, a train of vanadium steel gearing is connected from the main 250 h. p. motor to the inside axles of all of the four trucks, two at each end of the car. To allow proper equalizing, the swiveling of the four trucks required a somewhat elaborate design, which, however, has worked out successfully in practice. This gearing can be readily disconnected by means of a lever arrangement so that the crane can be hauled at high speeds.

It will be readily appreciated that with so many motions to be cared for and such a large amount of machinery, the lever arrangement must be carefully designed and constructed so as to avoid unnecessary complications and enable the operator to put the crane through all its functions with ease and certainty. The arrangement provided is such that there are two locations for the operator, one for each end of the crane, each system being complete for that particular crane.

The main motor, operating all of the motions described above, is controlled by a master switch, which operates the main contactors on the switchboard. Dynamic braking is also provided so that the motor may be quickly stopped as desired, and there is sufficient resistance in circuit so that the motor may be run indefinitely at a very slow rate of speed, and thus give better control for all of the motions.

All of the clutches are operated by air cylinders, located in close proximity to the clutches themselves, so that it is only necessary to lead the piping to a bank of three-way and four-way valves conveniently located for the operator. This system has been found very satisfactory, and as the clutches can be handled with ease, the operator is greatly assisted in performing his work expeditiously and accurately. An engineer's valve is also provided, operating the air brakes of the car, so that the whole equipment is entirely under the control of the engineer.

To provide necessary air for operating these clutches, and also for operating the braking system on the trucks, an electric air compressor is installed, controlled automatically, and with a large reservoir to give ample supply for the purpose.

As indicated above, the crane is ordinarily operated through the third-rail, ordinary locomotive type of contact shoes being supplied for this purpose. When the rail is dead, however, as is usual in the case of a wreck, connection is made to the circuit by means of an extra flexible cable, 1,000 ft. of which is wound on a drum located on the car body and can be led off down the side of the tunnel through suitable fiber-lined guide sheaves. This system is operated automatically by means of a motor, so wound and so connected to the drum by means of suitable gearing that a constant torque is exerted on the drum at all times. By this means the cable is paid out or wound up on the drum automatically, as the case may be; or, if the crane is standing still, the winding motor remains stationary but with current still on it. The winding and resistance are such that no injury is done by this plan of operation. To avoid abrasion of the insulation of the cable when winding on and off, an automatic device is provided which shall wind the cable on evenly and prevent one layer climbing on another. The above arrangement is very necessary in practice and is convenient and efficient.

The capacities of the crane vary, depending on the position of the boom and the conditions of operation; but for work within the tunnel it is impossible to swing the booms farther than 15 deg. to either side of the center, so that the most important capacities are those within this range.

A portable counterweight, intended to be handled by the boom not actively in service, is provided, which materially lightens the wheel loads and brings them within the limits required by the specification. This counterweight is not required except in extreme cases, however.

Capacities 15 deg. each side of center of track: Without counterweight, main hoist, 40 tons at 22 ft. 6 in. radius; auxiliary hoist, 15 tons at 17 ft. 6 in. radius; with counterweight, main hoist, 50 tons at 22 ft. 6 in. radius; auxiliary hoist, 15 tons at 17 ft. 6 in. radius.

In each case both of the above loads may be handled or carried suspended at the same time.

Capacities up to 90 deg. each side of center of track: Without counterweight, main hoist, 45 tons at 17 ft. radius; with counterweight, main hoist, 50 tons at 17 ft. radius.

The above capacities are all given without the use of any jack beams or other side support.

The total weight of this crane in working order is 326,000 lbs., the axle loads being arranged so that under maximum working conditions the load on any axle shall not exceed 74,500 lbs.

The crane was built by the Industrial Works, Bay City, Mich., and was thoroughly tested before shipment.

GRAVEL WASHING PLANT OF THE RICHMOND, FREDERICKSBURG & POTOMAC AND WASHINGTON SOUTHERN.*

By S. B. Rice, engineer maintenance of way.

About the time the double tracking of the Richmond, Fredericksburg & Potomac and the Washington Southern had been completed in the latter part of July, 1907, the officials were discussing the matter of using stone ballast to make the line first-class in every respect, as it is a through trunk line between Richmond, Va., and Washington, D. C., with a very heavy traffic. An average of 24 through passenger and 10 local trains are handled daily during the heavy season and an average of 20 through passenger and 10 local trains daily during the light season, the through trains consisting of from six to twelve cars and the local trains of from four to five cars. We also have an average of 20 freight trains daily throughout the year. The weight of the heaviest engine is 156,730 lbs. on drivers; and the total weight, 373,200 lbs.

Ballast and Water Passing Over Bars.

About this time a heavy deposit of very excellent gravel was discovered at Massaponax, Va., 57 miles from Richmond and midway between that point and Washington. The gravel lies in a bed from 10 to 20 ft. in depth, about 800 ft. wide and 4,000 ft. in length. The pit was estimated

*From report of committee on ballast in bulletin 141 of the American Railway Engineering Association.

to contain about 1,000,000 cu. yds. of serviceable material, and was opened on August 22, 1907.

The pit-run gravel from this pit was used on portions of our track and made an excellent track, but in dry seasons it was found to be very dusty, and in wet spells the track became sloppy. In the latter part of 1907 we conceived the idea of washing and screening this material, as was done by the Lake Shore & Michigan Southern at Roupel and Pleasant Lake. In July, 1908, W. D. Duke, assistant to president; S. B. Rice, engineer maintenance of way, and E. M. Hastings, resident engineer, made a trip to the Roupel plant to look into the advisability of duplicating this plant, also to inspect track that had been ballasted with washed gravel. Mr. Duke was so much pleased with the condition of the track and plant that he at once recommended the installation of the washing plant at Massaponax at the earliest possible time. The authority for this work was given in the latter part of July, 1908. Work was at once started on this plant and pushed as rapidly as possible to have it completed before bad weather set in. The first shipment of washed gravel was made on November 20, 1908.

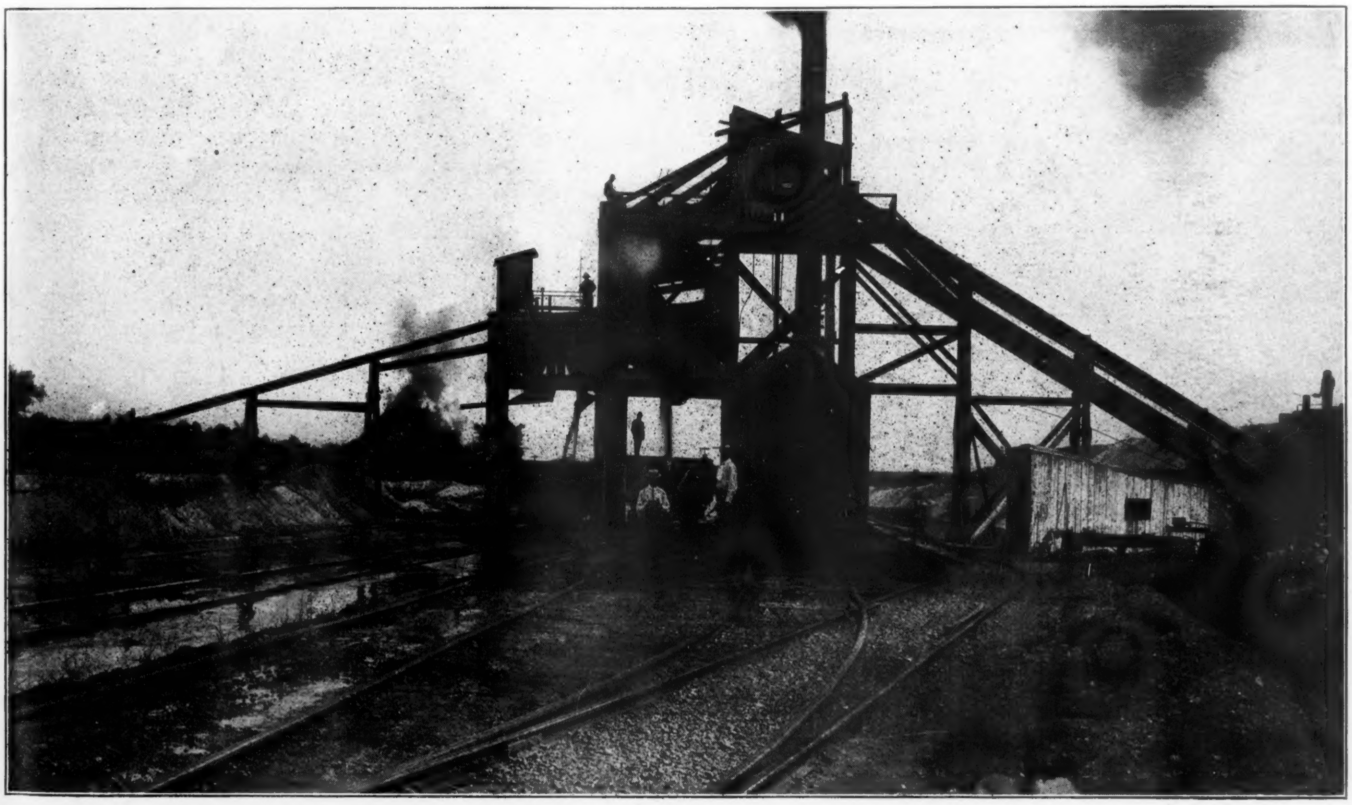
The plant consists of a large concrete hopper into which the pit-run gravel is dumped and from which it is carried by a pan conveyor having a speed of 30 ft. per minute, or 120 to 150 cu. yds. per hour, on an incline of 30 deg., to the top of the trestle some 45 ft. high, where it is discharged into a steel-lined box, 6 ft. by 3 ft. in plan and 1 ft. deep in front, or at the chute. The water is discharged from a flat nozzle, 1 in. wide and 24 in. long, connected to a 6-in. discharge pipe, and strikes the gravel as it falls into the box, washing it over a steel-lined chute, 6 ft. wide and 8 ft. long, with a slope of 3 in. to the foot. It was found necessary, in order to more completely wash the gravel, to place a series of rods across the chute, making the gravel tumble over them, thereby retarding its progress and obtaining a more complete washing.

At the end of the chute a double screen is placed at an angle of about 45 deg. with the chute. The screens are about 9 in. apart, and are of double-crimped tool steel wire. The first screen is of No. 6 wire, one mesh to the inch; the second of No. 10 wire, two meshes to the inch. All gravel that does not pass these two screens falls into the ballast bin, which is 36 ft. long, 12 ft. wide and about 12 ft. deep. The lower 6 ft. of this bin is sloped toward the center, so that the gravel will fall by gravity through the openings in the bottom.

All of the material which passes these two screens along with the water falls upon a second steel-lined chute which is 8 ft. wide, 9 ft. long, and has a slope of 2 in. to the foot. From this chute the material is discharged against another screen of double crimped tool steel wire No. 12, four meshes to the inch. This screen takes out practically everything larger than ⅛ in. in diameter. All material which does not pass this screen falls into the ballast bin also.

The material passing the screen is carried over another steel-lined chute about 10 ft. wide and 7 ft. long, where it is discharged as sand into a settling tank about 12 ft. by 13 ft. and 3 ft. deep. On the side of the tank opposite this chute is the waste flume where the muddy water is carried off and discharged on the bed of gravel where the gravel had been previously excavated.

The settling tank is water-tight and is fitted at the bottom with two conical steel hoppers, 6 ft. in diameter at the top and 10 in. in diameter at the base, 5 ft. deep. The bottoms of the steel cones are fitted with a steel cone plug which makes them nearly water-tight. The plugs or cones are operated from the top. The idea of having two of the conical hoppers was to grade the sand, the coarse sand settling in the first hopper and the fine sand in the farther one, there being a distinct difference in the two grades of sand. For this sand we have found ready sale, as it is of excellent quality for building purposes and concrete work, the finer sand making excellent engine sand.



Loading Both Sand and Ballast at Gravel Washing Plant.

The ballast bin is steel-lined throughout and has three openings at the bottom, fitted with 20-in. by 20-in. rack and pinion valves, spaced so as to empty into the center and two ends of the ballast car, giving a uniform loading without necessitating the moving of the car. The material is distributed in the ballast bin about equally over the three openings.

The water is brought from Massaponax creek through a gravity canal, 900 ft. long, to a concrete-lined well, 7 ft. by 5 ft. and 11 ft. deep; the bottom of the well being 4 ft. lower than the creek at the intake. This canal is a 20-in. by 20-in. open wooden flume for 500 ft. where it runs into a 20-in. by 20-in. wooden box, covered by some 8 ft. of earth. This box is about 370 ft. long. Connection is made with an 18-in. terra cotta pipe, which runs under the engine foundation and the pull-out track into the well, which is located close to the engine; this flume is always submerged. The pump is an Emerson No. 4 pump, with a 6-in. suction, and is rated for a 5-in. discharge. The rated capacity is from 800 to 1,200 gal. per minute. To overcome friction it

was fitted with a 6-in. discharge. The steam is furnished by a 90 h. p. return tubular boiler, which is under the same roof as the engine and pump. There is also a No. 5 pulling pump, rated at 350 gal. per minute, to pump water into a 25,000 gal. tank about 1,400 ft. distant, for the use of ballast and spotting engines. This tank is located on the pull-out track, just north of the coal bin. At this point office and bunk houses are provided for both white and colored help, the bunk houses being separated. Steam shovel and spotting engine crews are provided with both lodging and board.

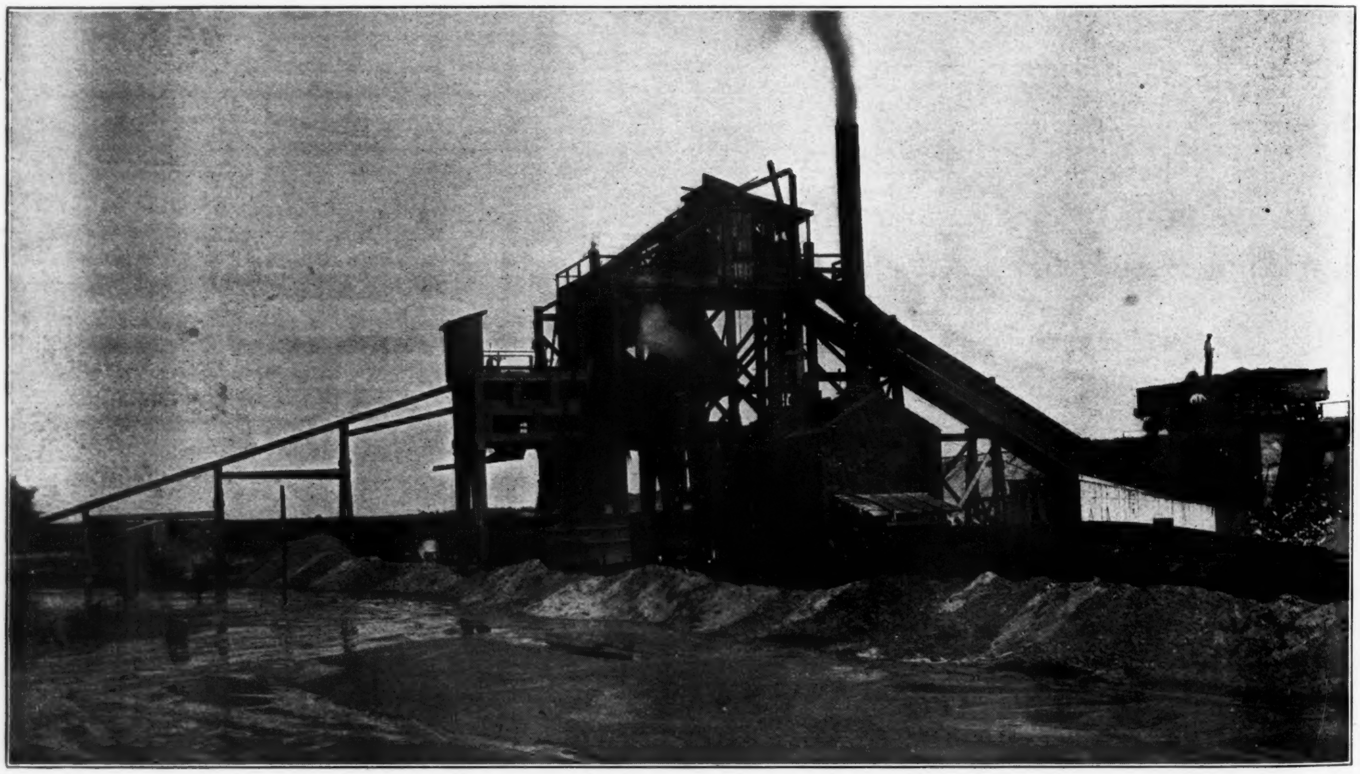
The concrete hopper, into which the pit gravel is dumped preparatory to washing, is 18 ft. above the foundation, 36 ft. long and 12 ft. wide inside, the outside walls being 2 ft. thick. The inside of the hopper slopes from the top on all sides toward the center opening, which is 18 in. by 20 in., and provided with a steel sliding door which governs the feed on the conveyor. The slant sides of the hopper are 6 in. thick, reinforced with from ½ to 1½-in. iron rods, spaced 18 in. on centers and bent over into the 2 ft. outside walls. They are fastened together with ½-in. rods spaced about 12 in. apart. The track on the hopper is carried on 12-in. by 14-in. wood stringers, one of which is immediately over the outside wall, the other carried on 12-in. by 14-in. cross stringers, spaced 6 ft. center to center, and imbedded in the outside walls. The track over the hopper is fitted with a bar screen, bars spaced 4½ in. apart, so as to prevent roots, stumps, boulders, or large lumps of clay from being carried to the washing plant.

The approach to the hopper is on a 2 per cent grade ascending, to a point 150 ft. from the end of the hopper, thence on a 1 per cent descending grade, over the hopper, after which is breaks into a 2.5 per cent descending, then to a 5 per cent descending grade for about 150 ft., then to an 18 per cent ascending grade. At the junction of the 5 per cent and 18 per cent grades a spring switch is located, the track leading away from the switch being on a descending grade to the pit level, the idea being to do most of the shifting by gravity. After being pushed up the 2 per cent approach to the hopper the loaded cars are unloaded, dropped down the 5 per cent grade by gravity, and up on the 18 per cent grade which gives them a kick back through the spring switch and down to the pit level, where they are taken by the engine to be reloaded.

It is intended to cover the 112 miles of double track with washed gravel, thereby securing a dustless roadbed. In order to accomplish this new grades were given, making a lift in track from 3 to 16 in., taking out some slight sags. Of course. where the track was lifted as much as 6 in. the old ballast could be worked under the ties, but at the other points the old sand and gravel ballast was thrown out to make roadbed. Ballast was loaded into the Rodgers drop bottom ballast cars and delivered in the track, using a Rodgers plow for leveling down. This work was carried on by an extra force, renewing all ties that were not good for two years, regaging track and properly spacing ties ahead of new ballast. The renewal of ties and regaging was charged to maintenance; surfacing track was charged to reballasting. It required from 3,200 to 3,800 cu. yds. of gravel to the double track mile. The force employed at the pit consists of the following: One general foreman, one clerk, one shovel engineer, one craneman, one shovel fireman, four men at shovel, one engineer in charge of plant, one towerman who operates the machinery at the top of the plant, also looking after the screens, one foreman on hopper, one hopper and two helpers, one sand loader, one gravel loader and two droppers of cars. In addition to this there are three men on cars closing them up and calking and getting them ready for sand. Shifting track is generally done by the section force and is, of course, charged to pit expense.

Since the starting of the washing plant 371,877 cu. yds. of washed gravel have been shipped, of which 354,439 cu. yds. were used for ballast and 17,438 cu. yds. for concrete and other purposes. From this total amount of gravel has been taken 78,232 cu. yds. of sand, most of which has been sold for building purposes. Of course, the hauling of this has been revenue to the company. The cost per cubic yard of loading rough gravel was 8.95 cents; cost per cubic yard of washing gravel, 11.34 cents; cost per cubic yard for hauling, 11.11 cents; cost per cubic yard for placing in track, 26.15 cents; or a total cost of 57.55 cents per cubic yard of finished track. This cost includes hire of all engines, train crews, coal and supplies; rental of shovel, coal, supplies and repairs; 1 cent per cubic yard to cover cost of gravel in pit and 10 per cent depreciation on plant and tracks; but no credit is taken in these figures for sand sold.

We have found by actual test that the washed gravel is nearly self-draining; it will not retain over 11½ per cent of water, while the pit-run gravel will retain 55 per cent. It has been demonstrated that the washed gravel will withstand any amount of continued rain and not slop, while the pit-run would, causing rough track in continued wet spells. Aside from the better condition of track we estimate to add at least two years to life of the ties. It makes a dustless roadbed and reduces the cost of maintenance.



View of Gravel Washing Plant, Showing Gravel Car and Hopper.

At the Coliseum

A NOVEL CALCULATOR.

A unique adaptation of the principle of the slide-rule as a labor-saving device for hydraulic and structural engineers is on exhibition by the Des Moines Bridge & Iron Co., at the Coliseum. Given any loading on any span, the required section may be determined by a simple operation of the calculator. The proper thickness of steel plates for tanks, boilers and pipes subjected to any pressure or head of water may also be ascertained by means of this device.

The calculator is made of a cardboard slide, working in a celluloid envelope or sleeve. One side is used to show the proper sizes of Bethlehem or standard beams and channels, used singly or in multiple, for any system of loading and for a considerable range of spans. The other side is employed for calculations in designing stand-pipes, tanks and boilers. A typical stand-pipe calculation is made as follows: Setting the calculator for the known head of water and diameter of pipe, the necessary thickness of plate may be read direct for any assumed unit stress and joint efficiency, tables for the latter being shown.

The Des Moines Bridge & Iron Co. also shows a slide-rule which is designed for a number of special uses. As an example of what may be done with it, the total weight of 25 plates 42 in. x ¼ in. x 15 ft. 6 in., and, if desired, their value at $1.20 per cut may be obtained at one setting.

IMPROVEMENTS IN THE ROCKFORD MOTOR CARS.

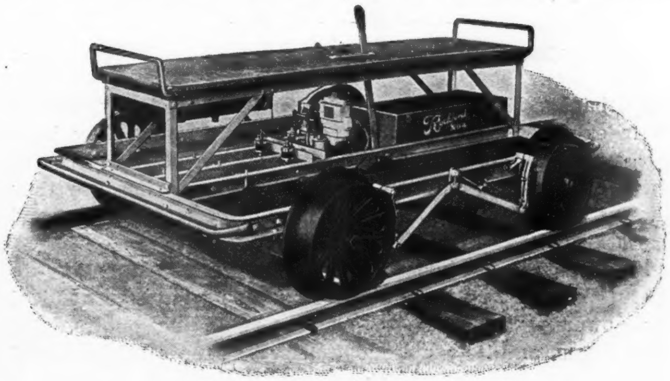
The development of the Rockford motor car has been continued steadily by the manufacturers, the Chicago Pneumatic Tool Company, Chicago, and a number of important improvements have been added recently.

One of these is the use of steel frame construction. These cars have been built with this type of construction for about eighteen months and it has been found that this is more satisfactory for service than the old-fashioned wooden frame. The Rockford cars were originally built with wooden frames; and, while they were satisfactory, it was found that long service tended to loosen the frames and get the working parts out of alignment. With the idea of remedying this the makers decided to build the frames of steel channels. The first frames put into use were riveted together and, while they were found to be much stronger and more satisfactory than the wooden frames, they were not perfect because it was found to be practically impossible to so rivet the frames as to prevent them from gradually loosening. It was then that oxy-acetylene welding was applied to the building of the frames, and it was soon demonstrated that this would overcome the former difficulties. Being one solid piece, the frame cannot shake loose in service, and will hold the working parts of the car in perfect alignment for the full life of the car. Its use also enables the cars to be built with lower and more easily accessible platforms and longer wheel base than formerly. The frame takes up less space and materially lessens the number of pieces used for the platform. For the No. 4 and No. 5 cars 3-in. channel is used for frames, while 2-in. channel has been found amply strong for the No. 2 or inspection car.

Another improvement has been made by the adoption of a new connecting rod. This rod has a pocket formed near the crank end of the rod are die cast babbitt, and a slot lubricating oil when the car is in use. The bushings on the crank end of the rod are die bast babbitt, and a slot is left in one bushing. Two holes are drilled through from the chamber containing the oil into the slot in the babbitt bushing and a felt wick is inserted to carry the oil from the chamber to the bearing surfaces on the bushing, thus providing a positive lubrication for this bearing. All the operator of the car has to do is to see that there is oil in the chamber, which has a knurled and slotted plug easily removable for filling and easily accessible to the operator. The chamber in the rod is large enough to hold an amount of oil sufficient to amply lubricate the bearing for 300 miles of travel. On test it is claimed that Rockford cars equipped with this type of connecting rod have run as much as 330 miles on one filling of the oil chambers.

This manner of oiling does away with the necessity of using oil cups on the connecting rods, and provides a more simple and reliable lubrication for the bearing. The chamber in the connecting rod holds two or three times as much oil as the average connecting rod oil cup and consequently requires filling less frequently. It cannot waste the oil; every drop put into it is fed to the bearing, and there is no possibility of breakage in ordinary service. It feeds the oil continually from the inside outward to the bearing and this tends to wash out any dirt, grit or other such matter as might work into the bearing from the outside. The oil pocket has a drain plug on the lower side which is easily removed at any time, and which enables the user of the car to flush out the pocket and drain off any dirt which might have been in the oil. No grit, dirt or any sort of foreign matter can reach the bearing surface from the oil pocket because it cannot pass through the oil wick.

The application of gears to the driving of the cam shaft on the engine which propels the Rockford cars is another recent development. Having the engine direct connected



New Rockford Motor Car.

to the drive axle of the car, these cars have never used chains for any purpose except for driving the cam shaft, and the substitution of gears and shaft for this drive consequently does away with all necessity for sprockets and chains on the cars. The cam shaft of the engines is now driven by spiral gears and an intermediate shaft. The gears and shafts are entirely enclosed and run in oil, insuring lubrication and protection from water and dirt, and it is claimed that there is no possibility of the car getting out of time because of wear.

The gear driven cam shaft is now in actual service on a large number of cars, and it is stated that it has been found to be entirely satisfactory in every respect. On the older types of Rockford section cars some trouble in connection with chain driven cam shafts was experienced, owing to the fact that the distance between centers was considerable, and it was absolutely necessary that the chain remain tight. Wear on the chain and its consequent elongation resulted in throwing the car slightly out of time when run in a reverse direction and thus prevented the engine from operating at its maximum efficiency. With the gear driven cam shaft this cannot happen, and much more service can be gotten from the car without replacements.

A fourth development is the adoption of the magneto ignition which is now being applied to these cars. The manufacturers have been putting out their cars equipped

with high tension magnetos for several months and find that the demand for cars with such ignition is much greater than that for battery ignition equipment, and is constantly increasing.

The application of the magneto to the Rockford car permits its makers to eliminate entirely dry cell batteries, spark coil and timer; and to have the whole ignition system in one unit. They use a magneto of the high tension type which is operated by a double throw cam on the cam shaft of the engine. This magneto is simple in design and operation, does not require the use of either a switch or a timer and has no electrical contacts. It requires no adjustments—in fact has no parts which can be adjusted—and produces a very hot spark which is quite independent of the speed of the engine. The strength of the spark, and its consequent ignition value, is the same at any speed at which the car may be running. The magneto has only two parts which can be said to be subject to wear at all. On test one of the magnetos was run 5,000 miles on a No. 4 Rockford car without showing any appreciable amount of wear on any parts.

The working parts of the magneto are all entirely enclosed, making the whole ignition system both dirt and water proof. The space taken up by the magneto is approximately 10 in. x 6 in. x 3 in. and its weight 12 lbs. It is a cost reducer, as the necessity for the constant buying of dry cells for battery replacements no longer exists and the usual item of spark coil repairs is also eliminated. The magneto is so located as to be easily accessible to the operator of the car at all times.

OIL ENGINES.

Fairbanks, Morse & Co., Chicago, have an innovation at their exhibit at the Coliseum this year, in that they have two engine outfits running under their own power. Both of these engines are interesting to railway men because they show a new way to "Economy" in railway maintenance and operation.

Not many years ago, the internal combustion engine to operate on gasoline was advocated as being more economical for power plants, pumping stations, charging outfits, etc., than steam, and its rapid adoption proved the manufacturers'

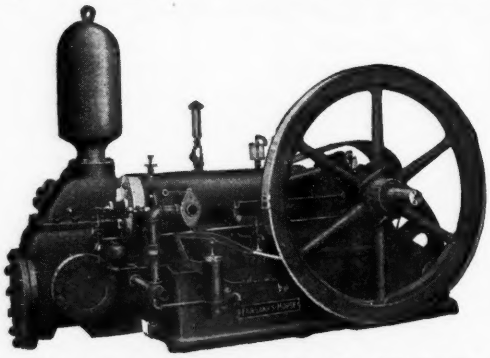
Fairbanks-Morse Combined Oil Engine and Pumper.

claim. Gasoline then was cheaper than now, due principally to the present extensive use of automobiles. The manufacturer, looking ahead, saw this coming, and the result is the "oil engine."

The generating outfit consists of a nine H. P. special electric oil engine, vertical type, direct connected to a 5½ K. W. generator. This is a straight oil outfit, starting and operating on oil, but it will operate also on gasoline, kerosene, naphtha, or any of the lighter distillates. The outfit is being used for additional lighting at the Fairbanks-Morse exhibit.

The 10 H. P. combined engine and pump is operating on the same oil as the generating outfit, and is pumping water from a large tank in the basement of the Coliseum, discharging it back into the tank.

The water supply is one of the most important questions in railway work. Locomotives must have water, no matter



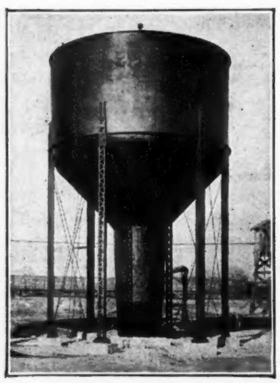
Fairbanks-Morse Type T Special Electric Oil Engine, Direct-Connected to Fairbanks-Morse Dynamo.

what the cost, and the management must get an adequate supply at the least possible expense. The gasoline pumping engine has saved thousands of dollars in water station expense, and it is claimed that the oil pumping engine will save even more. Oil suitable for use in these engines can be purchased in most any part of the United States at from two cents to four cents per gal., in tank car lots. Comparing this with the cost of gasoline makes the saving that can be accomplished at once apparent. A varied assortment of the oils is shown at the exhibit, and the localities where they can be purchased are given.

SELF-CLEANING TANKS.

The Chicago Bridge & Iron Works, during the past year, have brought out an all-steel tank, designed especially for locations where the water contains a large amount of sediment.

The tank illustrated was built for the Chicago & Northwestern at Boone, Ia. It has a combined conical and ellipsoidal bottom with a conical mud drum. The whole tank tapers down to the bottom of the mud drum, where the blow-off valve is located, and there is no possible chance for any accumulation of sediment elsewhere. Instead of emptying the tank to clean it, all that is necessary is for the operator to turn the handle of the blow-off valve. It is claimed



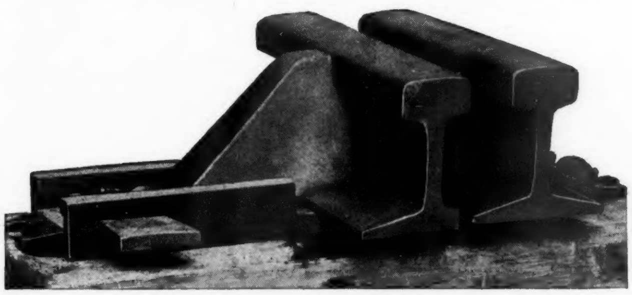
Self-Cleaning Tank.

for this tank also that it has the advantages of an all-steel construction with no wood frost casing, viz., long life and low maintenance charges.

CRANE GUARD RAIL RETAINER.

The Crane guard rail retainer is a new device which seems to receive considerable favorable comment. It is a departure from the clamp type of retainer, in that it is an adjustable brace tie plate. It has been in trial in the track under severe conditions for the last four or five years. However, during the past twelve months, special attention has been devoted to the development of this guard rail retainer into a shape permitting its marketing under advantageous conditions as to durability, strength and price.

The device is very firmly constructed, and consists of five large parts. It has no bolts or small delicate parts to break. The tie-plate portion is banjo-shaped and provides a large wearing surface for the traffic rail and a smaller wearing surface for the guard rail, which carries no direct vertical load. Heavy jaws grasp the outside edge of the traffic rail and substantial ways, or guides, are provided to retain the brace, which bears against the inside of the guard rail. Suitable spike openings are provided in the plate to spike it to the tie outside the traffic rail and also at the point inside the guard rail, thereby fastening the plate to the tie inde-



Crane Guard Rail Retainer.

pendent of any of its adjustable portions. It is possible, if desired, to lag-screw the plate to the tie, and this method of attaching it is recommended as one which will add to the life of the tie and in general increase the ability of the plate to properly perform its purpose. Through the ways near the end of the smaller portion of the plate are provided openings in which the wedge is driven to force the brace against the guard rail, locking the whole device into proper working position.

The brace which operates in the ways on the plate is a substantial malleable iron rail brace of approved design. The foot portion of the brace beyond the rail is formed at a proper angle to act in conjunction with the adjusting wedge. The adjusting wedge is a simple piece of malleable iron provided with three spike openings and a wedging surface formed to act with the wedging surface provided on the brace above mentioned. By means of the three spike holes in the wedge and the two spike holes provided in the tie plate, it is possible to obtain four adjustments of the guard rail as its head wears. The usual adjustable chocks are provided, except that the serious objection of these chocks jarring out of their place under vibration has been overcome by providing them with exceptionally deep teeth and with a simple means of anchoring to the tie plate.

The study of the device set up in place reveals it as a slight departure from the old non-adjustable method of fastening a guard rail in place by means of rail braces and bolts, as well as combining the desirable features of a heavy tie plate and a strong clamping device reinforced by the heavy switch timber.

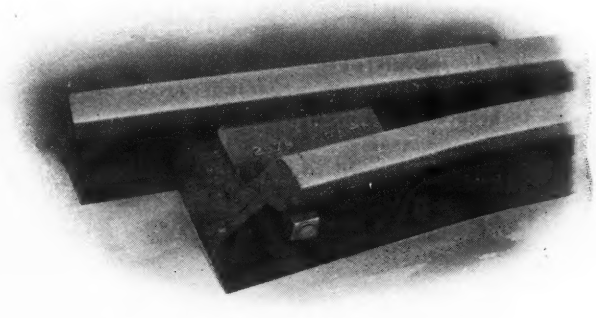
The Crane guard rail retained is simple to put into service. The tie plate is firmly seated on the tie, as any tie plate is. The brace, wedge and chocks are applied in the only manner it is possible to apply them, the whole device being tightened up and spiked home. When only one retainer is used to hold a guard rail, it should be placed substantially opposite the point of the frog. When two are used they should be spaced on either side of the frog point along the track about that distance from the point in either direction.

Every part of this device is made of malleable iron, heavily and substantially designed. It is made by the P. & M. Company, Chicago, and is on exhibition at the Coliseum.

TWO NEW GUARD RAIL CLAMPS.

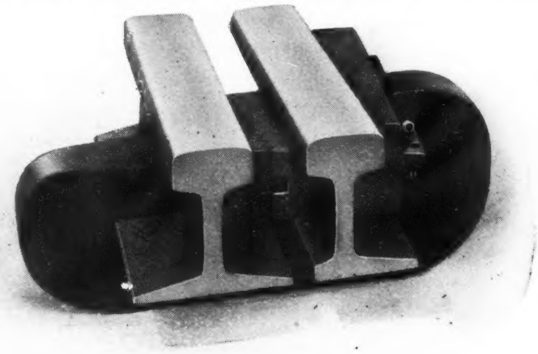
A very large portion of guard rail troubles arise from insecure and poorly held guard rails. While the proper design of the guard rail itself is of the utmost importance, it is essential that it be rigidly held in position with the required throat, or, to be more exact, to the proper distance from the opposite frog point.

An easy and economical method of meeting these requirements is by means of a good, strong, adjustable guard rail



Adjustable Guard Rail End Block.

clamp. The two clamps here illustrated are die forged from a single piece of 1¾ in. x 3½ in. wrought iron and aside from their strength and simplicity, there being only four parts in each, they have the additional advantage of being so designed that they can be readily placed in position and tightened up to any required throat without disturbing the guard rail itself,—a point of considerable merit and one that simplifies the application of the clamp, particularly where they



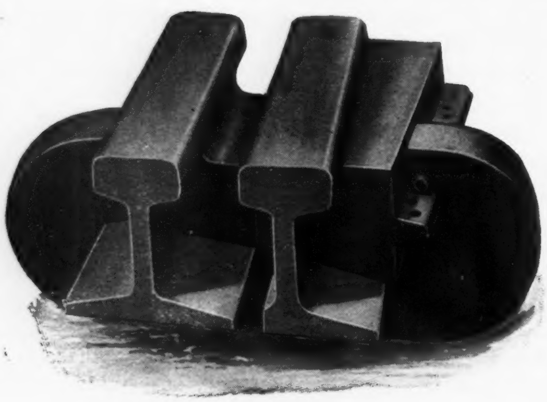
Detector Bar Clamps.

are applied to guard rails already spiked in position, as is frequently the case.

These clamps are made in two forms, "Standard" and "Detector Bar." In the standard clamp the metal of the clamp proper is forged to fit the fishing and in addition is carried up outside the head to within about ¾ in. of the top,—a feature which gives a strong grip on the rail.

The detector bar type is, as its name implies, especially designed to permit its use in interlocked or signal territory where detector bars are employed, and while the clamp on the stock rail side is necessarily depressed to clear the detector bar, the strength is maintained by spreading or flaring out the metal to a width of over three inches and in such a way as to give an accurate fishing fit.

It is claimed that one clamp at the center of an 11-ft. guard rail is all that is required, especially if adjustable cast blocks are used at each end. These blocks act as foot guards, besides adding to the strength and rigidity of the guard rail, and by a simple method of staggered holes, can be readily adjusted to give any required width of throat.



Standard Guard Rail Clamp.

The two clamps described above in connection with the standard 11-ft. guard rail with adjustable end blocks are manufactured by the Morden Frog & Crossing Works, Chicago, and may be seen at their exhibit in the First Regiment Armory.

SCHERZER ROLLING LIFT BRIDGE.

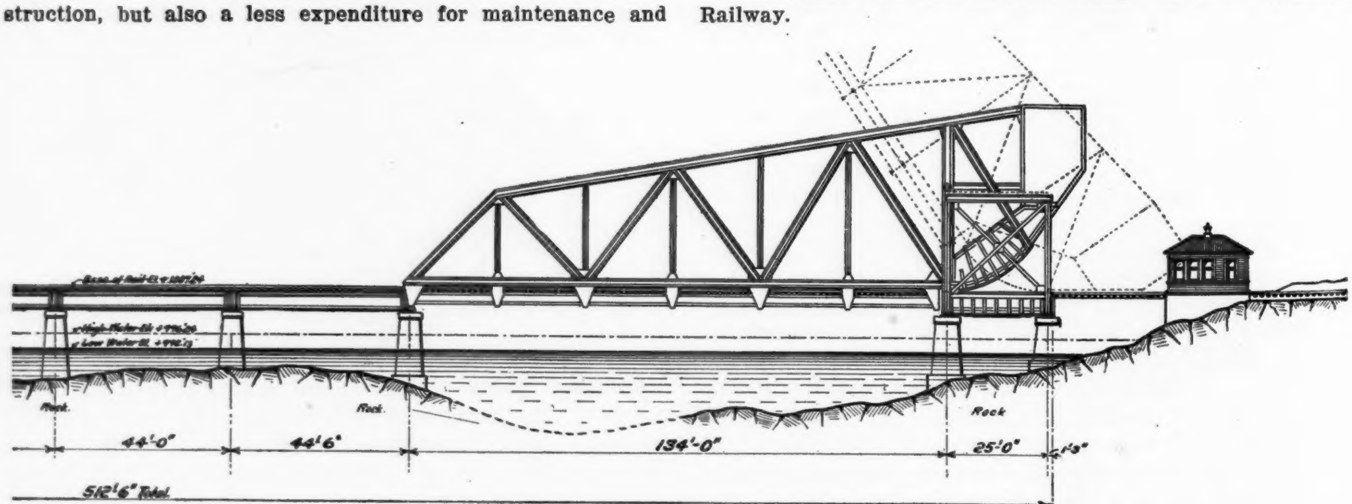
The advantages and economy of the Scherzer rolling lift bridge are illustrated by the recently completed bridge of the Scherzer type across Rainy River at Pither's Point, for the Duluth, Rainy Lake & Winnipeg railway. The general design of the movable bridge and approach spans is shown in the accompanying drawing, while the photograph shows a view of the completed structure.

After making a very careful comparative study of the cost of a center pier swing bridge and of the Scherzer rolling lift bridge, the railway decided to adopt the Scherzer bridge, as it not only involved a less expenditure for construction, but also a less expenditure for maintenance and operation. The center pier swing bridge would have to be long enough to span two channels, although one channel is all that is required for navigation. This effected a large saving in structural steel. A further saving is effected because only a partial opening of the Scherzer bridge is required for the maximum size vessels navigating the river, this advantage resulting in a considerable saving in machinery.

The structure consists of a simple truss to which is directly and rigidly attached the segments or rockers characteristic of the Scherzer type of bridge, the counterweight to balance the structure being plain concrete encased in a steel box, also firmly and rigidly attached to the segments and trusses—the entire movable structure forming one piece. The Scherzer rolling lift bridge is operated by rolling forward and backward on smooth and level tracks. The friction is so slight and the balance so perfect that the bridge can easily be operated by hand power. The rail lifts and end lifts necessary with the center pier swing bridge are entirely dispensed with in the Scherzer rolling lift bridge. The rails are firmly and rigidly attached to the movable bridge structure.

Scherzer Rolling Lift Bridge Across Rainy River for the Duluth, Rainy Lake & Winnipeg.

The Scherzer Rolling Lift Bridge Company of Chicago, Albert H. Scherzer, president and chief engineer, furnished the designs, plans and specifications for the bascule span, and maintained a general consulting engineering supervision over the construction and erection of this portion of the bridge, the entire work being in charge of H. T. Hare, chief engineer of the Duluth, Rainy Lake & Winnipeg Railway.



General Plan of Scherzer Rolling Lift Bridge Across Rainy River at Pither's Point; D., R. L. & W.